CTPS TECHNICAL REPORT 29b

NEWTON-NEEDHAM RACMs PROJECT: FINAL REPORT

CTPS TECHNICAL REPORT 29b

TITLE NEWTON-NEEDHAM RACMs PROJECT: FINAL REPORT

AUTHOR(S) BOB REYES, DENNY LAWTON, HEIDI O'BRIEN

DATE FEBRUARY 1, 1983

ABSTRACT This study reports on traffic and air quality effects of having implemented a multi-employer ridesharing program in a suburban office/industrial park. In March 1981, traffic and air quality data were collected in the New England Industrial Park, located in Needham, beside Route 128. During November 1981, an aggressive ridesharing program was promoted among fifteen employers in the industrial area. Follow-up traffic and air quality data were collected during March 1982. In this particular case, the ridesharing program little influenced either local street traffic or local air quality. However, this outcome is much related to the circumstances of this particular setting and this moment in time. Under different circumstances, ridesharing may have the potential to reduce local traffic congestion and improve air quality.

This study is funded under a grant from the Environmental Protection Agency (Air Quality Section 175 funds).

Preparation of this document was financed with funds from the United States Department of Transportation supported with matching state and regional funds.

CENTRAL TRANSPORTATION PLANNING STAFF 27 School Street, Boston, Mass. A Cooperative Planning Effort of MAPC, EOTC, MDPW, MBTA, MBTA ADV. BD., MASSPORT.

AUTHOR(s)
Bob Reyes (CTPS)
Denny Lawton (MAPC)
Heidi O'Brien (DEQE)

Graphics:
Diane McHenry
Joe Ulatowski
Keith Hudson

Editing:
Lee Morrison

Secretarial:
Sandra Barron

EPA/UMTA Grant
MA-19-0013

Production of this document was financed with funds from the UNITED STATES DEPARTMENT of TRANSPORTATION FEDERAL HIGHWAY ADMINISTRATION, through technical study grants from the UNITED STATES DEPT. of TRANSPORTATION URBAN MASS TRANSPORTATION ADMINISTRATION, and with state and local matching funds.

Copies may be obtained from Central Transportation Planning Staff 27 School Street, Boston MA 02108

TABLE OF CONTENTS

	LIST OF FIGURES AND TABLES	vi
	ACKNOWLEDGMENTS	ix
	SUMMARY	xi
A.	PROJECT BACKGROUND	1
	1. INTRODUCTION	1
	2. AIR QUALITY AND HEALTH	1
	3. HEALTH EFFECTS	3
	4. AIR QUALITY LEGISLATION AND MASSACHUSETTS POLICY	3
	5. AIR QUALITY IN THE BOSTON METROPOLITAN REGION	4
	6. THE RACMS STRATEGY	6
B.	SCOPE OF STUDY	9
C.	METHOD OF STUDY	11
	1. INTRODUCTION	11
	2. THE RIDESHARING PROGRAM	11
	3. THE TRAFFIC SURVEYS	13
	4. AIR QUALITY MONITORING	15
D.	THE RIDESHARING EFFORT	16
	1. PREVIOUS EFFORTS	16
	2. THE NEWTON-NEEDHAM COMMUTER PROGRAM	17
	a. The Planning Stage	17
	b. Implementation	18
	c. Follow-Up	21
	d. On-Going Efforts	22
E.	EMPLOYER'S SURVEY	23
	1. DISTRIBUTION AND FOLLOW-UP	23
	2. SURVEY RESULTS	23
	3. RESPONSE TO RIDESHARING BY EMPLOYEES	23

TABLE OF CONTENTS (Cont.)

F. TRANSPORTATION ISSUES 25

1. ROADWAY CONDITIONS 25

a. Highland Avenue/Needham Street 25
b. Kendrick/Nahanton Street 26
c. Streets Within the New England Industrial Park 26

2. PRE- AND POST-IMPLEMENTATION TRAFFIC CONDITIONS 26

a. Peak-Hour Travel 27
1. Highland Avenue and Needham Street 27
2. Kendrick Street 37
3. Streets Within the Industrial Park 40
o First Avenue 40
o Third and Fourth Avenues 40
o Second Avenue 42
b. Second Avenue and Highland Avenue Level of Service 45
c. Travel Patterns in the Newton/Needham Industrial Area 47
1. Highland Avenue/Needham Street 47
2. Kendrick Street 48
3. Streets Within the New England Industrial Park 48
d. Metropolitan Commutation Patterns to the Newton-Needham Industrial Area 49

3. VEHICLE SPEED 51

a. Highland Avenue/Needham Street 51
b. Kendrick/Nahanton Streets 55

4. VEHICLE MIX 55

5. VEHICLE OCCUPANCY 59

6. PUBLIC TRANSPORTATION 64

G. AIR QUALITY ISSUES 66

1. INTRODUCTION 66

TABLE OF CONTENTS (Cont.)

2. MEASUREMENT OF CARBON MONOXIDE BY MONITORS IN THE FIELD 66

a. Monitor Site Analysis 66
b. Locating the Monitor 67
c. On-Site Monitoring 67

3. NMHC AND CO LEVELS AS ESTIMATED BY MODELING PROCEDURES 69

a. Microscale Analysis: Carbon Monixide (CO) 69
b. Caline-3 69
c. Mobile 2B 70
d. Results 70
e. Conclusions 70

4. MESOSCALE ANALYSIS: NON-METHANE HYDRO-CARBONS (NMHC) 70

H. CONCLUSIONS AND RECOMMENDATIONS 77

1. TRAFFIC AND RIDESHARING 77

2. AIR QUALITY AND RIDESHARING 79

3. THE RIDESHARING EXPERIENCE 79

4. RECOMMENDATIONS 81

APPENDICES

LIST OF FIGURES AND TABLES

FIGURE 1 STUDY AREA LOCATION 2

FIGURE 2 STUDY AREA CORRIDOR 7

FIGURE 3 LAND USE 8

FIGURE 4 AUTOMATIC TRAFFIC RECORDER LOCATIONS 28

FIGURE 5 24-HOUR TRAFFIC PATTERNS: HIGHLAND AVENUE BETWEEN FIRST AND SECOND AVENUES 29

FIGURE 6 24-HOUR TRAFFIC PATTERNS: MDPW AND FACTORED COUNTS: HIGHLAND AVENUE AT SECOND AVENUE, NORTHBOUND 30

FIGURE 7 24-HOUR TRAFFIC PATTERNS, MDPW, AND FACTORED COUNTS: HIGHLAND AVENUE AT SECOND AVENUE, SOUTHBOUND 31

FIGURE 8 24-HOUR TRAFFIC PATTERNS, FACTORED COUNTS: HIGHLAND AVENUE AT SECOND AVENUE, NORTHBOUND 33

FIGURE 9 24-HOUR TRAFFIC PATTERNS, FACTORED COUNTS: HIGHLAND AVENUE AT SECOND AVENUE, SOUTHBOUND 34

FIGURE 10 24-HOUR TRAFFIC PATTERNS, MDPW COUNTS: NEEDHAM STREET AT WINCHESTER STREET, NORTHBOUND 35

FIGURE 11 24-HOUR TRAFFIC PATTERNS, MDPW COUNTS: NEEDHAM STREET AT WINCHESTER STREET, SOUTHBOUND 36

FIGURE 12 24-HOUR TRAFFIC PATTERNS, MDPW COUNTS: KENDRICK STREET AT CHARLES RIVER, EASTBOUND 38

FIGURE 13 24-HOUR TRAFFIC PATTERNS, MDPW COUNTS: KENDRICK STREET AT CHARLES RIVER, WESTBOUND 39

FIGURE 14 24-HOUR TRAFFIC PATTERNS, FACTORED COUNTS: SECOND AVENUE AT HIGHLAND AVENUE, NORTHBOUND 43

LIST OF FIGURES AND TABLES (Cont.)

FIGURE 15 24-HOUR TRAFFIC PATTERNS, FACTORED COUNTS: SECOND AVENUE AT HIGHLAND AVENUE, SOUTHBOUND 44

FIGURE 16 TRAVEL SECTORS 50

FIGURE 17 HIGHLAND AVENUE-NEEDHAM STREET TRAVEL SPEEDS 54

FIGURE 18 KENDRICK STREET-NAHANTON STREET TRAVEL SPEEDS 56

FIGURE 19 LIMITS OF MESOSCALE ANALYSIS 74

TABLE 1 AWDT DATA AND A COMPARISON OF PM PEAK-HOUR MANUAL COUNTS WITH ATR COUNTS 41

TABLE 2 DISTRIBUTION OF RIDESHARING PARTICIPANTS' ARRIVAL TIMES TO THE NEWTON-NEEDHAM INDUSTRIAL AREA 52

TABLE 3 DISTRIBUTION OF RIDESHARING PARTICIPANTS' DEPARTURE TIMES TO THE NEWTON-NEEDHAM INDUSTRIAL AREA 53

TABLE 4 VEHICLE CLASSIFICATION: ALL TRAFFIC ENTERING AND EXITING INDUSTRIAL PARK, ALL SITES, 1981 57

TABLE 5 VEHICLE CLASSIFICATION: ALL TRAFFIC ENTERING AND EXITING INDUSTRIAL PARK, ALL SITES, 1982 58

TABLE 6 VEHICLE OCCUPANCY: ALL TRAFFIC ENTERING AND EXITING INDUSTRIAL PARK, ALL SITES, 1981 60

TABLE 7 VEHICLE OCCUPANCY: ALL TRAFFIC ENTERING AND EXITING INDUSTRIAL PARK, ALL SITES, 1982 61

TABLE 8 VEHICLE OCCUPANCY: ALL TRAFFIC ENTERING AND EXITING INDUSTRIAL PARK, ALL SITES, 1981 62

LIST OF FIGURES AND TABLES (Cont.)

TABLE 9	VEHICLE OCCUPANCY: ALL TRAFFIC ENTERING AND EXITING INDUSTRIAL PARK, ALL SITES, 1982	63
TABLE 10	5:00 PM CARBON MONOXIDE VALUES	71
TABLE 11	6:00 PM CARBON MONOXIDE VALUES	72
TABLE 12	NON-METHANE HYDROCARBON ESTIMATES: 1981 AND 1982	75
TABLE 13	COMPARISON OF 1981 AND 1982 PM PEAK-PERIOD TRAFFIC COUNTS	78

ACKNOWLEDGMENTS

As with most large and complex tasks, this study owes much to the efforts of many people.

Among those who deserve mention are the many staff members of CTPS and MAPC who stood out in the cold of March 1981 and 1982 to collect the traffic data for this study. This report also owes a debt to the people involved in its production: Diane McHenry, Joe Ulatowski, and Keith Hudson provided graphics; Lee Morrison edited the text and added to its coherence; Sandy Barron patiently produced this and several other drafts of this document.

Denny Lawton of MAPC co-directed this project and helped author the text. Heidi O'Brien of the Department of Environmental Quality Engineering also helped direct the course of this study and participated in producing this report. Jean Amato of CARAVAN was particularly helpful in promoting the ridesharing effort. The authors are especially indebted to Lew Songer of the Newton-Needham Chamber of Commerce for his involvement and steadfast support of this project.

While there will be errors and omissions in any study, responsibility for these lie not with the contributors, but with the authors.

SUMMARY

Until quite recently, most efforts to improve traffic operations and, consequently, air quality in urbanized areas have focused on affecting traffic in core areas. This study is significant in that it attempted to improve air quality by affecting traffic operation in a suburban office/industrial park.

The Newton-Needham RACMs project attempted to improve air quality by reducing the number of vehicles traveling into and out of the Newton-Needham industrial area. A ride-sharing program, called the Newton-Needham Commuter Program, was implemented to consolidate the number of commutation trips to the area. Program participants were expected to rideshare to work with other participants, making similar commutes at approximately the same time. Twelve of the area's employers actively participated in the program, creating a pool of 750 potential employee participants. Four hundred and fifty (450) of these were interested in ridematching; each of the 450 received a list of potential ridesharers. The lists were prepared by computer, distributed to a ridesharing coordinator at each participating firm and finally distributed to each interested employee.

Local traffic and air quality were expected to improve as a consequence of implementing the ridesharing program. To assess these potential changes, automated traffic counts were performed at seven locations throughout the area, and continuous carbon monoxide (CO) readings were taken at the principal, signalized intersection exiting the New England Industrial Park. These data were collected before and after the ridesharing program was implemented.

Traffic counts on Highland Avenue, Needham Street, and Kendrick Street indicated that, contrary to expectation, traffic increased during the assessment period.

During this same period, overall traffic into and out of the New England Industrial Park declined slightly, and vehicle occupancy decreased. Since the object of this exercise was to consolidate work trips, achievement of this goal would have been seen in a rise in vehicle occupancy. The decline in both indices indicated that fewer people were traveling to the industrial park after program implementation than before, but a greater percentage of them were traveling there alone.

The CO data indicate that neither the one-hour nor the eight-hour CO standard were violated either before or after implementing the ridesharing program.

It might be generally inferred that, within a surburban office/industrial park environment, ridesharing has no potential to improve local traffic or air quality. However, this would be a wrong conclusion.

In this specific case, the supply of parking exceeded demand, gasoline supply was plentiful, and gasoline price was stable. Were these conditions to change, so would the potential effects of a ridesharing program.

Several lessons should be gleaned from this experience. In the future, suburban-based ridesharing efforts should only be undertaken at office/industrial sites where the supply of parking is very limited relative to demand. Moreover, the ridesharing program must be strongly promoted by management, and management should also adopt incentives which support ridesharing, like preferential parking and subsidies to employees who carpool or vanpool.

NEWTON/NEEDHAM RACMs PROJECT: FINAL REPORT

A. PROJECT BACKGROUND

1. INTRODUCTION

On weekday afternoons, traffic along Highland Avenue/ Needham Street (in Needham and Newton, respectively) creeps in fits and starts as it moves toward Route 128. Traffic on secondary streets is equally congested. This situation makes the chore of commuting more onerous than it need be. It also wastes energy and exacerbates the air quality problem in the Boston metropolitan area.

In an effort to alleviate these problems, the Newton/ Needham RACMs Project is being implemented. RACMs are Reasonably Available Control Measures for improving air quality. This project is essentially a ridesharing program that aggressively promotes both carpooling and vanpooling. The specific goal is to reduce the number of vehicles used to commute to the Newton/Needham industrial area, especially during the peak commutation periods. The rationale for this effort is to discover if ridesharing can improve local traffic operations and, consequently, local air quality. The following section will examine the air quality issue and related policy decisions to show how they have influenced this project.

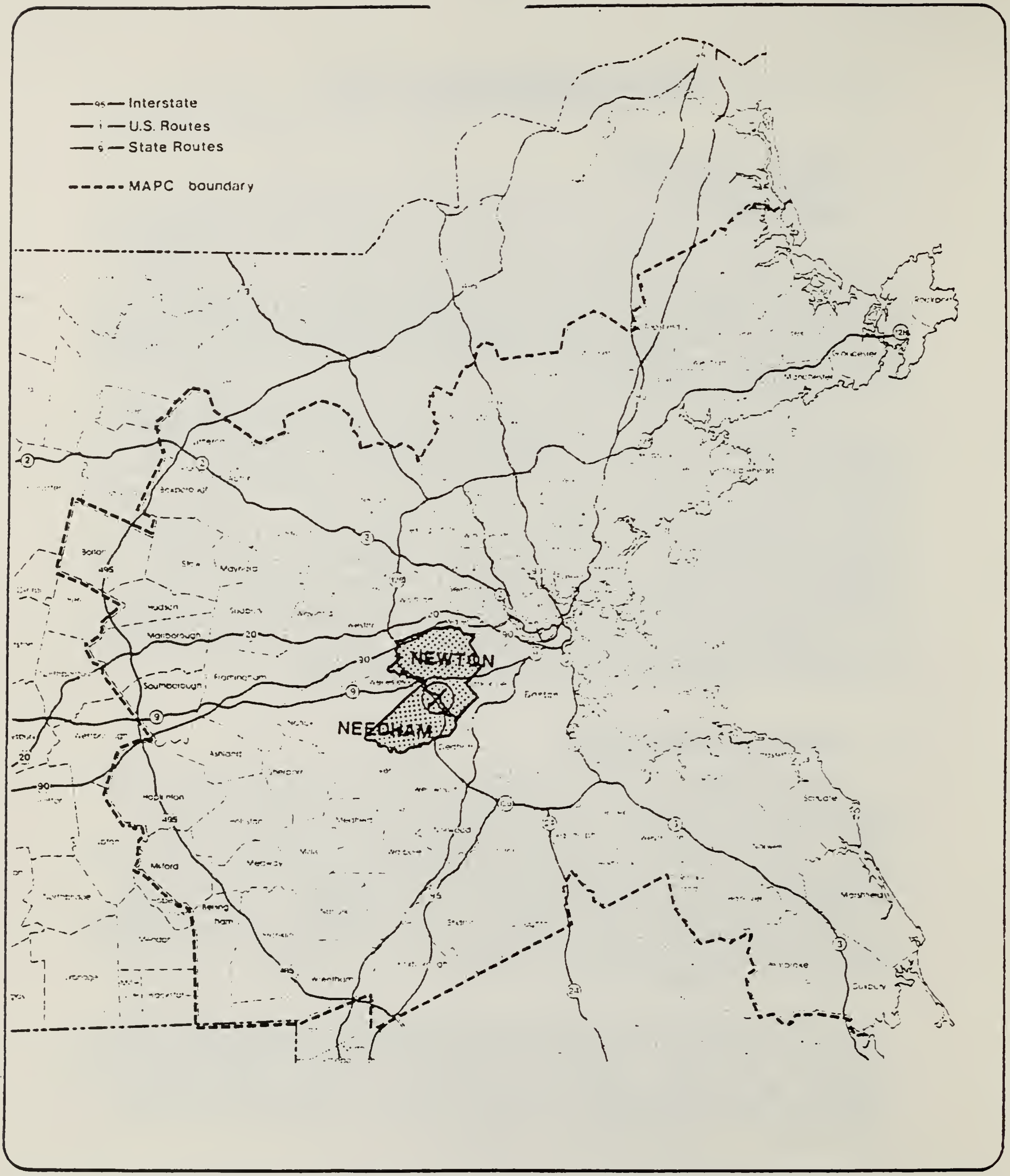
2. AIR QUALITY AND HEALTH

The purpose of the Clean Air Act of 1963 was "to protect and enhance the quality of the nation's air resources." To achieve this purpose, the Environmental Protection Agency (EPA) was created by the 1970 amendments to the Act with responsibility for all pollution-related activities. The 1970 Act specifically directed the EPA to establish maximum safe concentrations for seven major air pollutants. In setting the national standards, a Senate Public Works Committee determined that the basis for the ambient air standards should be the health of people.[1]

Of the seven pollutants for which there are standards, three of them are associated with motorized vehicles or mobile pollution sources. These are carbon monoxide (CO), hydrocarbons (HC), and nitrous oxides (NO_x). These three pollutants and their health effects are particularly relevant in this discussion of RACMs and air quality.

---

[1] This policy decision was made as a response to making technical feasibility the basis for ambient air standards.



STUDY AREA LOCATION

NEWTON-NEEDHAM RACM's STUDY

FIGURE 1

3. HEALTH EFFECTS

Ozone, commonly referred to as smog, forms in a reaction between nitrous oxides (NO_x) and hydrocarbons (HC) in the presence of sunlight.

Ozone is known to produce deliterious effects in humans. Ozone irritates the lungs, affecting the respiratory mucous membranes, other lung tissues, and respiratory functions. Clinical studies demonstrate that ozone produces chest tightness, coughing, and wheezing in healthy, as well as sensitive, individuals. Ozone particularly affects asthmatics; an elevated proportion of asthmatics experience attacks when the peak hour concentrations reach roughly 0.25 parts per million (ppm). (The National Ambient Air Quality Standard (NAAQS) for ozone was changed in 1979 from 0.08 to 0.12 ppm.)

Other demonstrated effects of ozone include toxicologic and aging effects. Exposure to ozone has been shown to produce increased susceptibility to bacterial infection in laboratory animals. Repeated exposure to ozone has also produced accelerated aging symptoms in laboratory animals, such as premature cartilage calcification and severe depletion of body fat.

CO is a health hazard because it is taken up by the hemoglobin in the blood more readily than oxygen. Hemoglobin is the substance which transports oxygen from the lungs to all other parts of the body. Therefore, the inhalation of CO inhibits the ability of blood to deliver oxygen to the body. This especially affects the nervous system and critical organs like the brain and the heart, which have a high demand for oxygen.

Exposure to CO is known to degrade an individual's time sense and ability to detect small changes in his or her surroundings. CO is especially dangerous to people with heart or respiratory disease. Their ability to function is impaired even by relatively low concentrations of CO. High concentrations of CO have been shown to produce the onset of angina and shortness of breath among people in these groups. Very high concentrations of CO can be fatal to anyone.

4. AIR QUALITY LEGISLATION AND MASSACHUSETTS POLICY

In 1977, the Congress amended the Clean Air Act of 1970. The 1977 Act required state and local governments to devise State Implementation Plans (SIPs) for meeting the National Ambient Air Quality Standards (NAAQS) by 1982. If a locality anticipated that it would not be able to meet the NAAQS before the deadline, it could apply to the EPA for an extension. For a locality to be eligible for an extension, the state

in which it was located was required to include in its SIP transportation strategies which would reduce mobile source emissions by 1982. The SIP was also to include an overall strategy for ensuring that the NAAQS would be attained by 1987.

In 1982, many areas throughout the country required extensions. The Commonwealth of Massachusetts requested and was granted extensions for the Boston metropolitan area and for the rest of the state as well.

As a consequence of being granted this extension, the Commonwealth is committed to a program of implementing whatever reasonably available transportation control measures are necessary to attain compliance with the standards. Some of these measures are directed toward improving and expanding public transportation. Others are directed at reducing vehicle emissions, such as the program of inspecting vehicles to ensure effective operation of emission control devices. These and similar actions, such as park-and-ride and fringe parking lots, regional parking management programs, pedestrian malls, etc., are called Reasonably Available Control Measures (RACMs).

The promotion of ridesharing is one of these RACMs. Heretofore, ridesharing and other RACMs have been promoted primarily in urban core areas. The Newton/Needham RACMs project is a unique effort to address a local traffic problem and, thus, regional air quality problems by promoting ridesharing in a suburban industrial/office park.

5. AIR QUALITY IN THE BOSTON METROPOLITAN REGION

Of the pollutants associated with mobile sources, i.e., nitrous oxides (NO_x), carbon monoxide (CO), and ozone, Boston is in compliance with only the nitrogen dioxide standard. The region has yet to meet the standards for CO or ozone.

At present, attainment of the ozone standard appears to be more problematic than that of CO. Hydrocarbon emission and ozone production are regionwide, as opposed to local, problems. Because ozone production is a photochemical reaction, it requires both sunlight and time to the completed. Pollutants produced in one area tend to create an ozone problem downwind from their source. Thus, because of the region's prevailing southwest winds, hydrocarbons and nitrous oxides generated in southwestern areas tend to be felt, as ozone, in northeastern areas.

The Massachusetts Department of Environmental Quality Engineering (DEQE) estimated that a reduction of 1977 hydrocarbon emissions by 70 to 80 percent would be necessary for

the region to meet the ozone standard. (This estimate assumes that all hydrocarbon emissions originating outside the region are not a factor.) Improvements in the design of new vehicles are significantly reducing hydrocarbon emissions per vehicle mile. However, the number of vehicle miles traveled in the region is increasing. Since the production of hydrocarbons is directly proportional to the number of vehicle miles traveled, hydrocarbon emissions and, consequently, ozone production continue to be problems in the region. At this moment, it does not appear likely that the ozone standard will be met by the 1987 deadline.

CO continues to be a problem in the Boston metropolitan region. Currently, there are five communities within the metropolitan area which do not comply with the CO standard. Unlike ozone, CO tends to be a local pollutant. It produces a negative effect on human life within the immediate area in which it is produced.

Moreover, CO also tends to be a seasonal problem, occurring during winter months. The peak CO season is generally from December through March. High concentrations of CO are apt to occur in cold weather because of engine temperature. A cold engine draws a rich fuel air mixture and also restricts the flow of air to the engine cylinder. The result is incomplete combustion and, consequently, high levels of CO production.

The CO problem in the Boston metropolitan area is perceived to be less severe than the ozone problem. This perception emerges from the prospect that by 1987 the Boston region will be in compliance with the CO standard owing to vehicle redesign and the state's program of vehicle inspection and maintenance.

6. THE RACMs STRATEGY

As mentioned earlier, the Commonwealth of Massachusetts committed itself to implementing a program of reasonably available control measures (RACMs) as a condition of being granted an extension of the deadline for meeting the NAAQS. (For a rigorous examination of the Boston experience with RACMS, see Analysis of Reasonably Available Control Measures to Improve Air Quality: A Summary of Case Studies for the Boston Region, Central Transportation Planning Staff, May, 1981.)

Most of these control strategies have concentrated on affecting travel into and out of downtown Boston. Prior to 1980, very little effort was made to implement control strategies in suburban environments. However, the Boston Metropolitan Planning Organization (MPO), on March 7, 1980,

submitted to the United States Environmental Protection Agency (EPA) a proposal to implement a program of RACMs in a suburban industrial/office park. The entire project was to be financed through the EPA Supplemental Section 175 Discretionary Fund from the Clean Air Act, as amended in 1977.

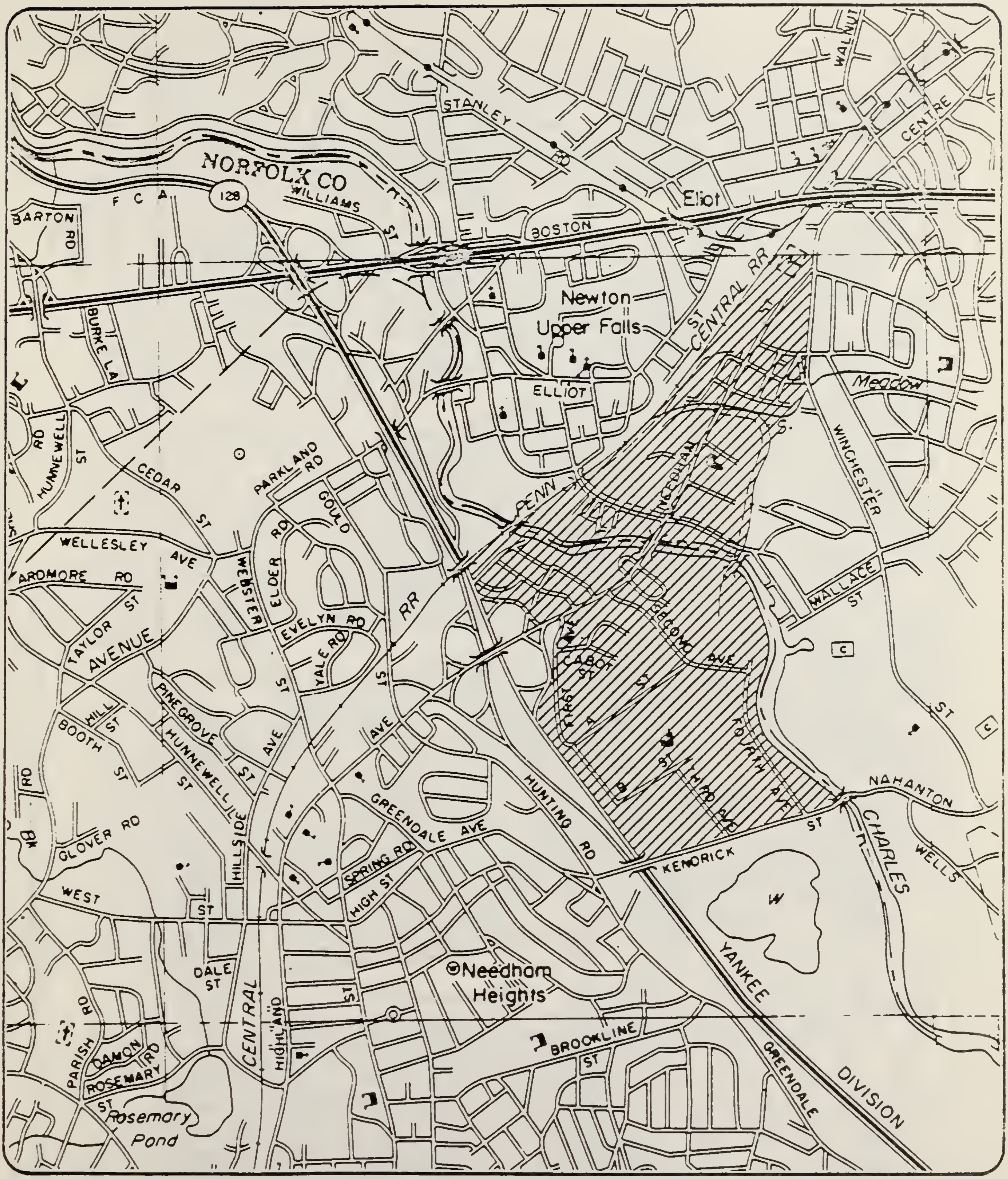
The rationale for this kind of strategy is that many jobs, which had traditionally been located in the urban core, have since the Second World War migrated to suburban areas. Thus, many of the vehicle miles traveled in the region are incurred as people travel from one suburb, where they live, to another, where the work.

On May 19, 1980, the Boston MPO received notification from the EPA that the Boston proposal would be funded. These funds were to be shared by the three agencies which would implement the program: the Central Transportation Planning Staff (CTPS), the Metropolitan Area Planning Council (MAPC), and the Massachusetts Department of Environmental Quality Engineering (DEQE). MAPC was named administrator of the contract.

On July 21, 1980, a proposed work program for selection of a suburban industrial/office park was sent to the SubSignatory Committee (SSC) of the Boston MPO for review. The SSC approved the work program on August 7, 1980. On September 10, 1980, the Boston MPO received the Section 175 Discretionary Funds from the EPA as part of the Fiscal Year 1981 technical studies grant, No. MA-19-0013, from the Urban Mass Transportation Administration (UMTA) and EPA.

CTPS, MAPC, and DEQE evaluated in a preliminary way eleven possible sites at which to implement the RACMs program. From among these candidate sites, five were chosen to be scrutinized in depth. The results of this analysis were published in December 1980 by CTPS in its Suburban Industrial/Office Park Reconnaissance Report. Later that month, using this information, the SSC selected the Newton/Needham Industrial Area for implementation of the RACMs program. The general area proposed for study is circled in Figure 1.

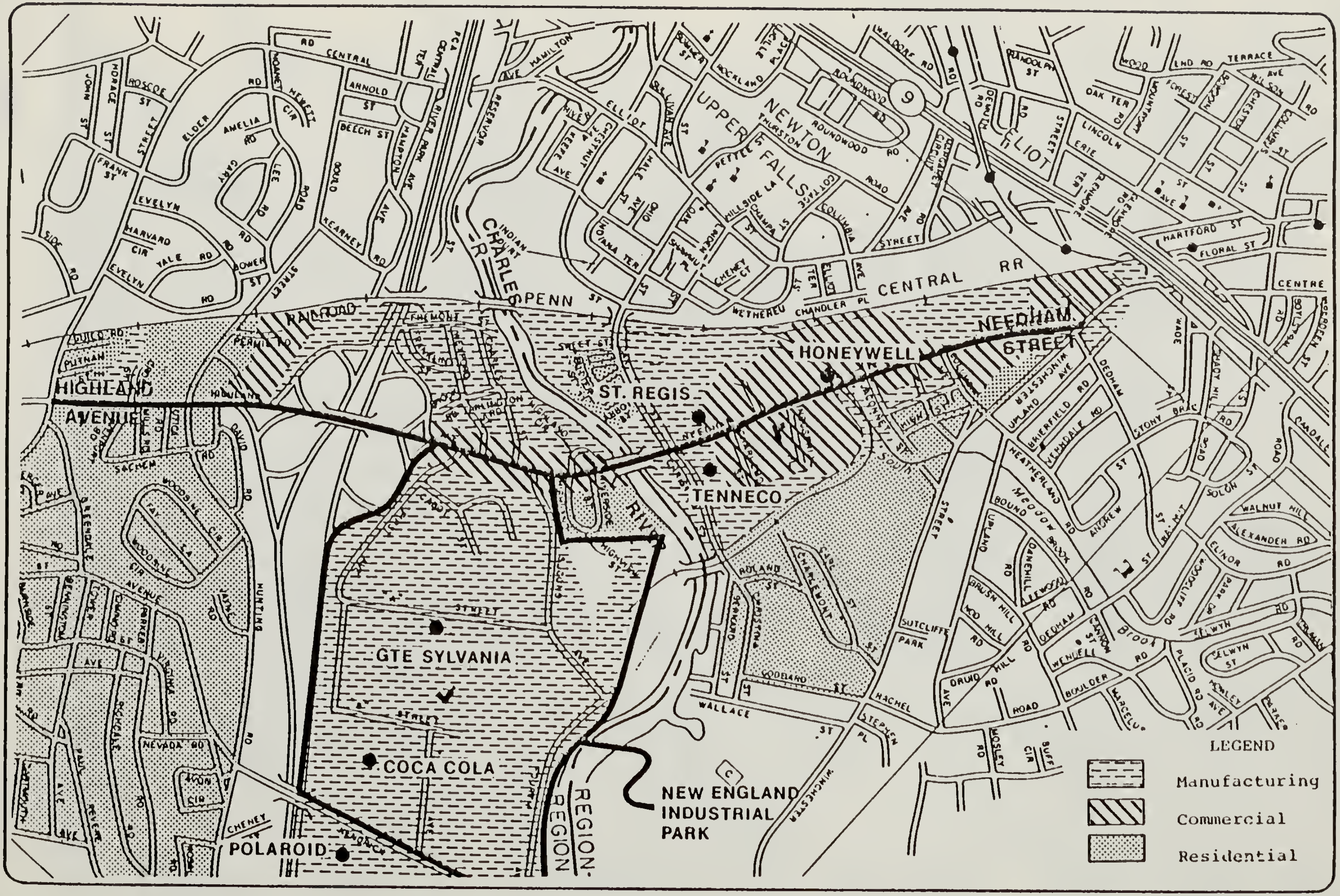
The area under study is shown in Figure 2. Figure 3 shows land use in the study area and the locations of the major employers.



STUDY AREA CORRIDOR

NEWTON-NEEDHAM RACM's STUDY

FIGURE 2



LAND USE

NEWTON-NEEDHAM RACM's STUDY

FIGURE 3

B. SCOPE OF STUDY

The general goal of the RACMs project is to evaluate the effectiveness of implementing packages of RACMs in improving ambient air quality in the Boston metropolitan area. Generally stated, any measure which improves traffic flow, reduces travel, or lowers vehicle emissions can be considered to be a RACM.

The Newton/Needham RACMs project has as its specific goal the improvement of traffic operations in and the reduction in travel to the Newton/Needham industrial area and, thus, the improvement of air quality in the immediate and the metropolitan areas. The RACM being used is an aggressive ridesharing program, called the Newton/Needham Commuter Program.

Ridesharing can reduce travel within an industrial/office park area by consolidating some of the trips now being made to and from the area. Many of the existing trips are made by various individuals who both live and work in roughly the same geographic areas. Often, their work start and work departure times are quite close, if not exactly the same. One impediment to their sharing a ride is that they do not know that they share their commute. This is especially likely to be the case when individuals work for different employers.

The objective of this multi-employer ridesharing program is to remove this impediment. This it accomplishes by creating one data set of all the journey to work trips for all participating employees. A computer matches participating employees who share a similar journey at roughly the same travel times. Because there are several employers participating in the Newton/Needham Commuter Program, the liklihood of discovering shared work commutes is better than it would be for only one employer. The computer then prints individual lists for all participants, containing the names and contact phone numbers of all people who wish to rideshare to work. The initiative for forming carpools and vanpools is left to the interested individuals.

The program is completely voluntary. No one is forced to provide information if he or she does not wish to do so. Even if an individual chooses to participate, the decision to form a carpool or vanpool is completely his or hers.

Ridesharing produces indirect benefits as well by reducing peak-hour travel. Reducing peak-hour auto travel decreases emissions indirectly by improving traffic flow. Emissions are proportional to vehicle stops and starts, as well as to the number of autos. Vehicle acceleration and deceleration produce higher levels of emissions than does locomotion at a constant rate. Therefore, the easing of congestion on local streets should reduce emissions.

Employers involved in the program have been encouraged to provide their employees with ridesharing incentives such as preferential parking for ridesharers, partial subsidies for vanpoolers, and flexible work hours.

The adoption of flexible working hours should produce results complementary to those of ridesharing. Flexible work hours permit employees to arrive at and depart from their jobs within specified periods of time. Usually, this program guarantees that all employees are on their jobs during a block of "core time." There are two blocks of time before and after the core period during which employees are reasonably free to arrange their own work hours.

This flexibility allows two or more people with a common commuting trip to select their individual hours and, thus, make ridesharing possible for them. Flexible work hours enhances the liklihood that a ridesharing program may succeed. Flexible work hours also affect peak hour traffic congestion by creating a period of, rather than a moment in, time during which the journey to work occurs. Assuming that people value their time, they will try to minimize their travel time and, thereby, their perceived travel costs by traveling before or after the peak moment. If this occurs, the peak travel period is extended in time: the intensity of travel, as measured by the number of vehicle per hour traversing particular local streets, is decreased. Thus, congestion and, consequently, CO emissions can be reduced by flexible work hours.

Ridesharing was promoted during October and November 1981. Employees who were interested in ridesharing were anticipated to form carpools or vanpools during November and December 1981. These newly-formed carpools and vanpools may have fluctuated in number at first, but the number should have stabilized by the late winter.

To assess the impact of this ridesharing effort, two sets of traffic and air quality data were used. The pre-implementation data were collected during March and April 1981. The follow-up monitoring occurred during March 1982, by which time any changes in the pattern of travel should have stabilized.

Hydrocarbon (HC) and nitrous oxide (NO_x) data were not collected because of the difficulty and expense of monitoring these pollutants. Moreover,it is possible to estimate the current levels of hydrocarbon and nitrous oxide production from the traffic data. These estimates are presented in this report, Appendix 18.

C. METHOD OF STUDY

1. INTRODUCTION

Selected transportation and air quality data collected during the spring of 1981 were collected again during the spring of 1982, after implementation of the ridesharing program. The two data sets were compared to assess the program's impacts. Other factors affecting local transportation or air quality were also monitored. For example, significant changes in the number or deployment of employees, especially at the largest employers, were carefully monitored.

Though it was impossible to hold constant every variable affecting local traffic patterns and concentrations of carbon monoxide, the effort here was to establish the extent to which ridesharing can affect local traffic and air quality and to quantify to the degree possible the changes induced.

2. THE RIDESHARING PROGRAM

The goal of ridesharing program was to engage the participation of as many employees of the Newton-Needham industrial area as possible. Toward this goal 140 managers (see Appendix 1) working in the area were invited by mail to enroll their company in the Newton-Needham Commuter Program, as the ridesharing program was called. Thirty (30) managers replied to the letter; of these, fifteen (15) chose to have their company participate in the ridesharing program. The fifteen participating companies represented a pool of approximately 6000 area employees. An employer survey was sent to all 140 managers in the area as an element of this first outreach effort. The survey is included as Appendix 2 to this document. The object of the survey was to assess each employer's experience with ridesharing and their susceptibility to implementing a ridesharing program.

Following a series of organizational meetings, program implementation was ready to begin. In mid-October 1981 program registration cards were distributed to a designated ridesharing coordiantor within each of the fifteen participating companies. The coordinator was responsible for distributing a registration card and collecting a completed card from each of his or her company's employees. Roughly 750 completed cards were collected by late October. They were readied for processing into computer-readable format in early November. By mid-November computer-generated matching lists were delivered to the ridesharing coordinators for distribution to interested employees.

The formation of carpools was left to individual initiative. Some thought was given to organizing one general meeting of all 425 area employees interested in ridesharing. It was thought

that a face-to-face meeting between potential ridesharers might facilitate the formation of carpools or vanpools. While this idea was well received by ridesharing coordinators, no company or group of companies came forward to organize and implement the meeting.

Distribution of the matching lists was completed, ridesharing coordinators were invited to two follow-up meetings. At the first meeting, held in mid-January 1982, the results of the computer matching effort were discussed. From this discussion came a recommendation to undertake a second round of commuter matching. The ridesharing coordinators agreed that this second effort should take place in the spring. A second organizational meeting was scheduled for late April. At that second meeting, it was agreed that on-going ridesharing efforts in the area should and would become principally a contingency planning activity since the price and supply of gasoline at the moment lent little impetus to the formation of carpools or vanpools. The second round of commuter matching, which had been planned for the spring, was postponed until August or September 1982. As of December 1982, that second effort had not materialized.

Specific observations concerning individual and employer participation in this ridesharing program are discussed in Section D.2 of this document.

3. THE TRAFFIC SURVEYS

The analysis of traffic data occurred at two levels. To assess general traffic volumes, Average Daily Traffic (ADT) counts were made by the Bureau of Transportation Planning and Development (BTP&D) of the Massachusetts Department of Public Works (MDPW). These were collected at seven sites during five weekdays in March 1981 and March 1982, starting at approximately noon on Monday and ending at about noon on Friday. Of these seven ADT counts, four were at the only four access roads to the New England Industrial Park. Thus, complete data were obtained for all traffic into and out of the industrial park.

From these data, the peak hour period was established; detailed traffic data were then collected at the four access roads to the industrial park. These counts included turning movements, vehicle occupancy, and vehicle mix. Peak-hour vehicle speeds were also established on the two arterials bordering the industrial park.

Other traffic-related data were also collected. An evaluation of road conditions on all streets within the industrial park was completed. Moreover, the number and type of automobile accidents on industrial park streets were analyzed, both before and after program implementation.

In evaluating the transportation effects of the ridesharing program, some of the traffic data were expected to be more sensitive than others. The vehicle occupancy count was anticipated to be among the more sensitive traffic indicators of program effectiveness.

Vehicle occupancy counts were performed in March 1981 and March 1982 at the four access points to the industrial park. The March 1981 count indicated that ridesharing was a significant travel mode in the industrial park even prior to the November 1981 ridesharing promotion. It is likely that this ridesharing was informally organized among colleagues within one business organization. This type of ridesharing appeared to have obvious limitations. Since the ridesharing program was organized among 15 neighboring firms, areawide ridesharing was expected to increase as people became aware of each other's shared journey to work. The March 1982 vehicle occupancy were expected to reflect this increase in ridesharing. The details of this and other traffic counts are discussed in Section F of this report.

On- and off-street parking counts were expected to be a second best indicator of the ridesharing program's effectiveness. Unfortunately, these counts were not performed. This lapse was due to circumstances beyond the control of people directly involved in this project.

In the spring of 1981 it was decided that aerial photos would be used to perform on- and off-street parking counts at a few selected sites in the Newton-Needham industrial area. This decision was based in part on resource limitations due to staff cutbacks at the Central Transportation Planning Staff (CTPS), the partner in charge of traffic analysis. The aerial photos were to have been taken in cooperation with the Massachusetts Department of Public Works (MDPW). The MDPW was to have provided their helicopter and CTPS a staff member and photo equipment to produce the aerial photos. However, due to severe cutbacks at the MDPW during the spring and summer 1981, the photos were never taken.

4. AIR QUALITY MONITORING

CO concentrations were monitored during March and April 1981 to establish a benchmark against which to measure anticipated changes. CO was continually monitored between October 1981 and April 1982. It was expected that if the ridesharing program were successful, there would be a decline in average daily traffic and, consequently, a decline in the concentration of CO.

The CO monitoring was perfomred by the Department of Environmental Quality Engineering (DEQE) near the one signalized intersection in the industrial park, on Second Avenue by Highland Avenue. This intersection was chosen for monitoring because it is the principal exit from the industrial park during the afternoon peak period. The queuing problem on the approach roadway is particularly onerous between 4:30 and 5:00 PM, causing a stop-and-go pattern of vehicle movement which produces relatively high levels of CO concentration. DEQE concurrently monitored meteorological conditions in the area, as these affect the values recorded by the air quality monitoring equipment. The details of the CO monitoring effort are discussed in Section G of this report.

D. THE RIDESHARING EFFORT

1. PREVIOUS EFFORTS

Responsibility for MASSPOOL--the statewide, employer-based ridematching organization--was invested in the MDPW Bureau of Transportation Planning and Development (BTP&D) in August 1977. Since then, BTP&D staff have participated in many technical assistance projects with major employers statewide.

On February 28, 1979, all companies in the New England Industrial Park were sent a memorandum from Edward M. Collagan, Director of the BTP&D, about the MASSPOOL ridesharing program. A meeting was held at Polaroid Corporation on March 20, 1979, to discuss the conducting of an employee survey. The following nineteen companies received the memorandum (the nine marked with an asterisk are those that sent representatives to the meeting):

- Addressorgraph Multigraph*
- American Door Distributors
- A. P. Parts Company*
- Bell and Howell
- Coca Cola Bottling Company
- Damon Corporation Headquarters
- Decatur Hopkins*
- Econocorp Torrington
- Fields Hosiery*
- Goodyear*
- GTE Sylvania Electric System
- Halliday Hospital Supply
- Kraft Food
- Manpower*
- Needham Electric Supply
- Polaroid*
- 3M Company
- Union Carbide*
- Upjohn*

Following the employee survey, employers had the data transferred onto computer-readable cards. The BTP&D then processed the information. One product was a density matrix, indicating how many local employees lived within each square of an imaginary grid covering the Boston metropolitan area. Using this information, lists of "geographically compatible" employees were generated. The formation of carpools was then the option of all undustrial park employees who had expressed interest in the ridesharing program. The ridesharing program met with limited success.

Other ridesharing efforts have been undertaken by Caravan. Caravan is a third-party vanpooling organization, whose goal is to organize into vanpools employees with common home and job locations. At present, there is one Caravan vanpool operating between the Fall River area and GTE Sylvania (located within the industrial park).

2. THE NEWTON-NEEDHAM COMMUTER PROGRAM

a. The Planning Stage

Prior to the commencement of matching activities, a series of meetings were held with a variety of agencies and individuals with experience in the ridesharing field. These included former MASSPOOL staff from the Massachusetts Department of Public Works and staff from the Department of Envronmental Quality Engineering, the Massachusetts Port Authority, and the Executive Office of Transportation and Construction. In addition to assistance from these agencies, the Executive Director of the Newton-Needham Chamber of Commerce provided invaluable guidance in developing a strategy for presenting the program to the area's employers.

These initial meetings, held in the fall of 1981, helped to identify sources of assistance for the project as well as define the goals and procedures to be utilized. Previous ridesharing efforts in the Newton-Needham area were analyzed and discussed to help tailor a program appropriate to the area. A decision was made to employ the MASSPOOL matching format rather than develop a new computer program--the latter would be time consuming and create unnecessary problems. Furthermore, the MASSPOOL materials were readily adaptable for use in the Newton-Needham area.

An initial organizational meeting was held with the area's largest employers on September 15, 1981. The agenda and minutes of that meeting are included here as Appendix 3. The meeting was hosted by GTE Sylvania, with those in attendance having been personally invited by the Executive Director of the Newton-Needham Chamber of Commerce. The purpose of the meeting was to present the program's background, goals, and method of operation to the area's largest employers for their response. Their suggestions were incorporated into the program prior to its implementation.

A variety of materials were circulated to transportation coordinators at the September 15, 1981, meeting, including a sample data card (see Appendix 4), a general invitation to employers to attend a "kick-off" meeting in October (see Appendix 5), and an Employer Survey form (see Appendix 2). This Employer Survey Form was used to gather background data

on the area's employers, to determine their interest in participation, and to be a means of identifying a transportation coordinator for each participating employer. The results of this survey will be discussed in Section E.

At this organization meeting, some concern was expressed concerning the extent to which employees would participate in such a program. However, it was agreed that the program would benefit those working in the industrial area and should get underway.

The announcement of the program's commencement, an invitation to attend the kick-off meeting, and a copy of the Employer's Survey Form were mailed to company executives who were members of the Newton-Needham Chamber of Commerce In mid-September, 1981. In some cases, this material was mailed to more than one individual at a firm with the expectation that the information would find its way to the appropriate recipient. The mailing list is shown as Appendix 1. Concurrently, the Newton-Needham Chamber of Commerce widely publicized the program through its newsletter, subcommittees, and personal telephone contact (see Appendix 6).

Fourteen firms were represented at the October meeting held at GTE Sylvania. A brief presentation was given concerning the program's purpose and operation. One of the meeting's primary topics was the means of distributing and collecting ridesharing materials. It was agreed that staff from CTPS and MAPC would distribute materials to ridesharing coordinators during the week of October 12, 1981. Coordinators would have three weeks to publicize the program, distribute data cards to employees, and collect completed cards. CTPS and MAPC staff would then collect the completed cards from the coordinators during the week of November 2, 1981, keypunch the data, and have the matching lists ready for distribution during the week of November 16, 1981.

b. <u>Implementation</u>

Distribution of materials to ridesharing coordinators was accomplished over a two-day period and involved direct contact between the coordinator and a CTPS or MAPC staff person. The transportation coordinator was given ideas for promoting participation at their plant, including ways to publicize the program, preferential parking for ridesharers, and flexible work hours to accommodate ridesharing. Also distributed were press release material (see Appendix 7) and posters (see Appendix 8) designed especially for the Newton-Needham area. MAPC and CTPS staff maintained contact with coordinators during the promotion period and provided support as necessary.

Name of Firm	Number of Employees (Rank as of 9/81)	Percentage of Employees Responding	Percentage of Respondents Interested in Ridesharing	Percentage of Total Employees Interested in Ridesharing
GTE Sylvania	1,900 (1)*	10 (9-tie)	64 (5)	7 (9-tie)
Honeywell, Incorporated	800 (2)	3 (12)	96 (2)	3 (12)
Damon Corporation	600 (3)	18 (6)	45 (11)	8 (8)
Polaroid Corporation	400 (4)	19 (5-tie)	68 (4)	13 (5)
St. Regis Paper	314 (5)	19 (5-tie)	54 (7)	10 (6)
NRC, Incorporated	210 (6)	31 (4)	55 (6)	17 (4)
NCR, Incorporated	200 (7)	2 (13)	100 (1-tie)	2 (13)
LTX Corporation	180 (8)	46 (3)	49 (9)	22 (3)
IMLAC Corporation	110 (9)	15 (7)	24 (13)	4 (11)
Tenneco, Incorporated	86 (10)	10 (9-tie)	89 (3)	9 (7)
Itek Systems	86 (11)	78 (1)	42 (12)	33 (1)
Impact Sales	63 (12)	5 (11)	100 (1-tie)	5 (10-tie)
3M Corporation	59 (13)	58 (2)	47 (10)	27 (2)
WXNE	57 (14)	11 (8)	50 (8)	5 (10-tie)
GE Company	45 (15)	7 (10)	100 (1-tie)	7 (9-tie)

*Numbers in parentheses denote rank within a category.

TABLE 1

RESPONSE TO RIDESHARING BY FIRM

In brief, the ridesharing effort was designed to be a multi-employer ridesharing program. The transportation coordinator, usually the company's personnel director, or a designee, was appointed to distribute data cards to all employees. Employees would complete a program registration card, providing information on their home and work locations and their commuting schedule. A sample card is provided in Appendix 4. They also indicated their ridesharing preference (vanpool, carpool, drive only, ride only, no interest, etc.). These cards were processed through use of a computerized grid system to match employees by home and work location and daily schedule. Matching information was made available to the transportation coordinator who, in turn, made the information available to employees. Employees were responsible for making contacts with each other and forming their ridesharing arrangement.

Most data cards were returned and quality checked prior to keypunching. The keypunching procedure was completed during the week of November 9. Approximately 800 data cards were received, of which 753 were usable. The return rate, by employer, is shown in Table 1. Out of the total respondents, 425, or 56 percent, expressed an interest in some form of ridesharing. The majority of respondents were interested in carpooling, but there was also substantial interest in both carpooling and vanpooling, as indicated in Table 2.

TABLE 2

RIDESHARING INTEREST

Category	Number of Respondents	Percentage
Carpool	240	31.9
Vanpool	12	1.6
Both	173	22.9
Not Interested	328	43.6
TOTAL	753	100.0

In addition to using the data cards to determine interest in ridesharing, questions were also included to ascertain commuting habits in the industrial area. As expected, the majority of respondents, 64.2 percent, drove to work alone. However, a sizable number, 32.3 percent, already carpooled. Less than one percent vanpooled. Only slightly more than one percent took public transportation to work. This finding is readily understandable, since transit service to this area is very limited.

By November 16, the data from employees was keypunched and matching lists were made available to ridesharing coordinators at the various companies. It was then the responsibility of the coordinator to provide the matching information to employees and to promote the formation of ridesharing arrangements.

c. Follow Up

On December 8, 1981, a meeting was held to review the results of the matching activities with individuals either interested or experienced in ridesharing. The minutes of that meeting are included as Appendix 9. The intention was to discuss the returns from the Newton/Needham program and to solicit ideas concerning program design. Ideas were also solicited regarding ways to improve the program in the future.

At the December 8 meeting, several ideas were advanced concerning the limited extent of participation. First, the 1981 economic recession resulted in layoffs at many local industrial plants. This, in turn, created anxiety among employees and an unwillingness to try a new personal transportation concept, since some employees were uncertain about the future of their job. According to the Newton-Needham Chamber of Commerce, a number of plants in the industrial area--including IMLAC, Honeywell, and Polaroid--experienced sizable reductions in work force. At the same time, however, GTE Sylvania increased its work force by roughly 200 employees. This may help explain the relatively minor changes to traffic levels within the industrial area. For a more complete discussion on this point, see Section F. Second, at least one of the major participating companies has a similar, but company-oriented, ridesharing program. Thus, this program may have seemed redundant. Furthermore, some employees were dubious of any program which came from or had the support of management. Finally, the program was being promoted at a time when gasoline prices had stabilized, and concern over the cost of commuting to work was not a high priority.

The participants at the December 8 meeting generally agreed that there should be a continued effort to promote ride-sharing in the Newton-Needham area. Consequently, a meeting was planned for mid-January at which transportation coordinators could share their ideas about follow-up strategies.

On December 17, 1981, a letter was sent to all transportation coordinators thanking them for their active participation in the program and inviting them to attend a meeting on January 19 at the 3M Company offices to discuss the results of the program to date, the feasibility of continuing the matching efforts, and ways to increase employee participation. A copy of this letter is included as Appendix 10.

At the January 19 meeting, transportation coordinators were able to share their experience with various implementation strategies. Appendix 11 is the minutes of this meeting. They agreed that there should be a second round of the matching effort. Some specific changes were suggested, however. Smaller companies, particularly those in the Wells Street area, should be encouraged to participate. Personnel departments should be distributing matching questionnaires to "new hires" as part of their orientation program, and information on terminations should be obtained in order to keep files updated. This information could be made available through mail room supervisors. Furthermore, a random survey of a limited number of previous respondents should be undertaken to ascertain how well the program has worked. Specifically, the survey would be used to determine the rate of carpool formation among the interested respondents.

Winter was not considered a good time to renew the program. There was consensus among participants that it should take place in the spring. In the meantime, the group agreed that transportation coordinators should be sent a copy of the minutes of the January 19 meeting, and the Chamber of Commerce and MAPC/CTPS should encourage additional companies to participate. A meeting was scheduled for mid-March to assess interest in and commitment to a final ridesharing effort. All transportation coordinators were invited to a March 16, 1982, meeting. A copy of this invitation is included as Appendix 12.

Attendance at the March meeting was very low, with only two companies represented. Those in attendance expressed dissatisfaction with the efforts of most employers in the industrial area. They felt that the program's limited success was due to the lack of program support given by upper management. It was agreed that a Chamber of Commerce Steering Committee on Ridesharing should be organized to promote on-going involvement in ridesharing with the full support of the business community.

d. On-Going Efforts

The first meeting of the Newton-Needham Ridesharing Program Steering Committee was held on April 22, 1982. It was generally agreed that a formal plan of action was necessary and that greater responsibility be given individual companies if the program was to survive. A member of the Committee volunteered to prepare a charter for the Committee with the intention of beginning active work in late summer.

Although a follow-up meeting of the Committee was scheduled for June 1982, no further meetings had been held as of December 1982.

E. EMPLOYER'S SURVEY

1. DISTRIBUTION AND FOLLOW-UP

As mentioned in the previous section, an Employer's Survey was distributed to all employers in the project area to better ascertain the nature of employment in the area, determine the extent of previous ridesharing promotions, and to establish the willingness of employers to participate in this ridesharing project. A sample of the survey form appears as Appendix 13. Of the 107 firms surveyed, responses were received from 25. As noted, multiple forms may have been sent to a single company with the expectation that the appropriate management person would respond. Only one response was, in fact, received from each firm. All of the major firms in the industrial area responded to the survey with the exception of one which, despite repeated requests from MAPC/CTPS and Chamber of Commerce staff, did not respond.

2. SURVEY RESULTS

The results of the survey are shown in Appendix 14. Of the 25 firms responding, 12 indicated a willingness to participate in the program. This accounted for employers representing 4,216 employees, Three additional firms expressed nominal interest in the project, but ultimately did not engage in company-wide promotion of ridesharing.

Of the firms responding to the survey, only eight firms offered some form of flexible work hours. Interestingly, five of these firms have less than 25 employees. Only one firm indicated serious problems in parking availability. This apparent surplus of available parking in the project area may help explain the relatively low rate of participation. Fourteen firms indicated previous involvement in the promotion of ridesharing. Six of the seven firms with over 200 employees had had previous experience with ridesharing.

3. RESPONSE TO RIDESHARING BY EMPLOYEES

The size of the firm and the nature of its operation appears to have little bearing on the response rate by employees. The two firms with the highest response rates, Itek Systems and the 3M Company, ranked 11 and 13, respectively, in terms of size. However, it should be noted that, of the five largest firms participating, none had a response rate of more than 20 percent. Itek Systems, with a response rate of 78 percent, encouraged each employee to complete a data card. The 3M Company experienced a 58 percent response rate. Although 3M did not require employees to complete a data card, company management did involve department managers in the promotion effort

and made follow-up requests to employees who did not initially complete a data card. GTE Sylvania, the largest employer in the area with 1,900 employees, extensively publicized the program through posters and bulletin board announcements, but had a response rate of only 10 percent.

Table 1 lists the ridesharing interest of those responding to the survey and the percent of the firm's employees interest in ridesharing.

F. TRANSPORTATION ISSUES

The object of undertaking the ridesharing program was to improve local traffic operations and, as a consequence, air quality. This section focuses on the former. This discussion begins with an inventory of the roadways themselves, moves on to issues of operation, and concluses with a note on transit and safety issues.

1. ROADWAY CONDITIONS

a. Highland Avenue/Needham Street

The poor physical condition of the roadway and the lack of roadway amenities make travel on Highland Avenue/Needham Street more troublesome than it would be otherwise. Much of the pavement is extensively cracked, both laterally and longitudinally. Opposing lanes of traffic are not separated east of First Avenue on Highland Avenue to the end of Needham Street at Winchester Street. Channelization is completely lacking on the entire Newton section of the roadway.

The current state of signalization bears further investigation for possible improvement. The only signal controls on the Newton side are flashing yellow beacons at Needham Street's intersection with Oak/Christina streets and further north with Winchester Street. In the Needham portion of the study area, only the Highland Avenue/Second Avenue intersection is signalized. The traffic problem here will be more fully discussed under peak-hour traffic patterns (Sections F.2.a and F.2.b).

Overhead lighting was improved along Needham Street in Newton during the fall of 1979, but lighting on Highland Avenue In Needham and signing and pavement markings on the roadway in both towns are either inadequate or entirely absent.

The width of Highland Avenue/Needham Street varies widely. At the intersection with Webster Street, the width from edge to edge of pavement is approximately 30 feet. Proceeding easterly, the approximate widths are as follows: 74 feet at the Gould Street/Hunting Road intersection, 80 feet at the Route 128 overpass, 60 feet between First and Second avenues, 29 feet (narrowing abruptly) at Cook's Bridge, 65 feet immediately after the bridge, 50 feet in the vicinity of Oak Street/Christina Street, and 60 feet to the intersection with Winchester Street.

The combination of the inconsistent roadway width with the numerous turning movements, due to the commercial nature of the area, seriously disrupts the traffic flow.

b. Kendrick/Nahanton Street

Much of the pavement on Kendrick Street in Needham is extensively cracked. Street markings are adequate, but curb markings are non-existent. Where curbs exist, street shoulder conditions are good, however, significant roadway sections have no curbs at all. Moreover, there is a total lack of overhead lighting.

Nahanton Street, the extension of Kendrick Street in Newton, is in significantly better condition. Roadway pavement and street markings are good; the entire length of the street has curbs; signage is adequate, as is overhead lighting.

Street width is consistent throughout the length of Kendrick/Nahanton Street at forty feet (40 feet) plus or minus a few inches. There is, however, no traffic channelization in either Needham or Newton.

There is no signalization on Nahanton Street, which causes problems. During the PM peak hour, access to the westbound lane of Nahanton Street from Wells Avenue is restricted, and long queues form along Wells Avenue. The problem is acute enough to necessitate traffic control by a police officer on a regular basis. By contrast, the signalized intersection of Kendrick Street and Hunting Road/Greendale Avenue appears to function smoothly even during peak periods.

c. Streets Within the New England Industrial Park

Much of the pavement of several streets within the industrial park is extensively cracked. This is particularly true of Second Avenue and "A", "B", and Cabot streets. Within the park, most streets were last paved in 1971. Roadway markings appear to have been painted since then, as they seem adequate. Curbing and shoulder conditions vary widely. Where there is curbing, shoulder conditions are generally adequate; where there is not, shoulders are often under stress and, in some cases, are crumbling. With the exception of Second Avenue, there is no overhead lighting on any of these streets. The pavement of all streets is forty-feet wide.

2. PRE- AND POST-IMPLEMENTATION TRAFFIC CONDITIONS

The following section is organized to be a comparison between local traffic conditions before and after implementing the ridesharing program. As such, discussion usually begins with observations made during March 1981 and compares these with similar observations made during March 1982.

Both the 1981 and 1982 counts were performed by automatic traffic recorders (ATR). The ATR's were installed by the MDPW at seven locations throughout the study area. These seven locations are marked on the map in Figure 4. Each count was performed at the same location in 1982 as in 1981.

a. Peak-Hour Travel

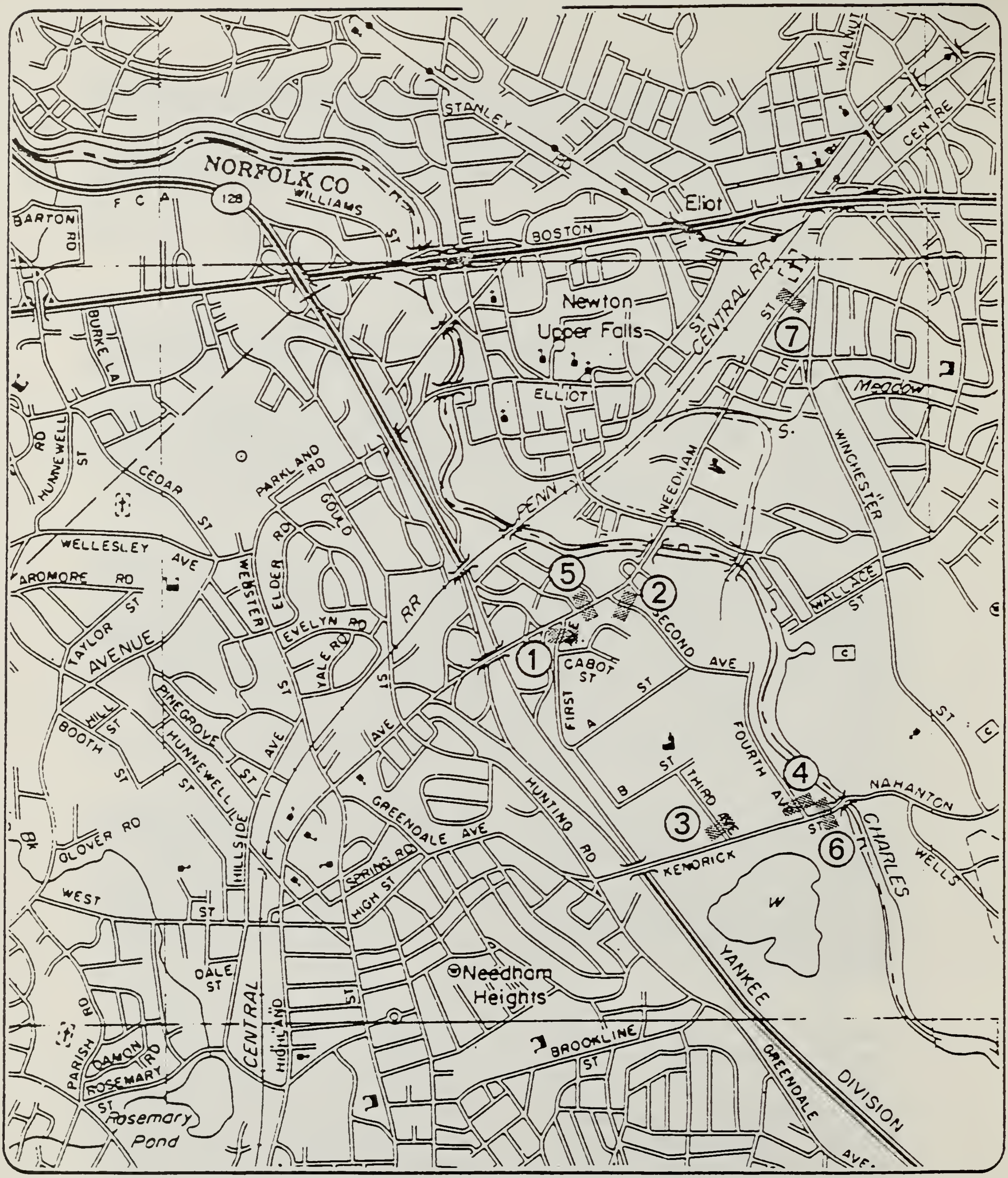
1. Highland Avenue and Needham Street

In March 1981, Highland Avenue functioned as a major access road to many of the area's businesses and industries. This observation follows from the plot of traffic volumes shown in Figure 5. As Figure 5 indicates, northbound traffic peaks between 8:00 and 9:00 AM. This reflects auto movement from Route 128 northward to local businesses and industries. The PM movement is the complement to the AM pattern: a strong peak occurs in southbound traffic between 4:00 and 5:00 PM, as motorists make their way back along Highland Avenue southbound to Route 128.

The 1981 MDPW data suggest that the AM peak-hour volume northbound is 2,600 vehicles per hour. These data further suggest that the PM peak-hour volume southbound is 2,400 vehicles per hour. Both of these values appear to be inflated. According to CTPS manual counts performed over three afternoons, the PM peak hour does, in fact, occur between 4:00 and 5:00 PM. However, these data indicate that the actual PM peak-hour traffic volume on Highland Avenue southbound is roughly 1,700 vehicles per hour. Thus, the MDPW counts appear to overestimate this volume by approximately one third.

Using the assumption that the 1981 MDPW data consistently overestimated traffic volume on Highland Avenue northbound and southbound, then plots of hourly traffic volume were factored from the MDPW data. These plots are thought to more closely represent actual traffic volumes. These curves are those shown in Figures 6 and 7. Each hour-by-hour ATR count and its factored counterpart are shown in Tables 1 and 2 of Appendix 15.

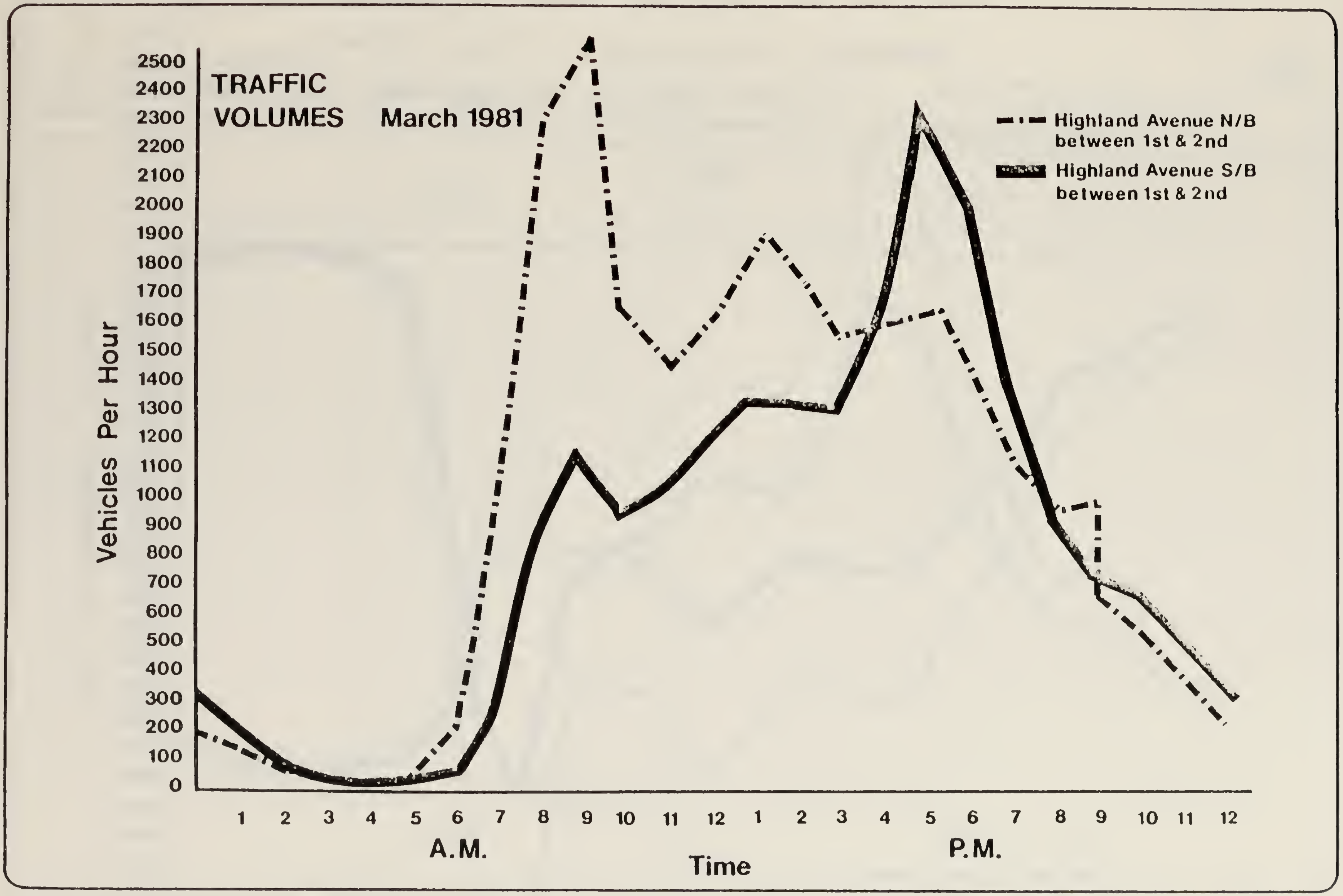
As noted earlier, after implementing the ridesharing program, the MDPW again performed traffic counts on Highland Avenue. These 1982 northbound and southbound counts were compared with manual PM peak-hour counts performed by the CTPS/MAPC staff. As with the 1981 counts, the 1982 ATR counts significantly overestimated PM peak-period traffic on Highland Avenue. Consequently, the 1982 ATR counts were factored down using the same procedure as previously discussed. Both the original and factored counts are given in Tables 1 and 2 of Appendix 15.



AUTOMATIC TRAFFIC RECORDER LOCATIONS

NEWTON-NEEDHAM RACM's STUDY

FIGURE 4

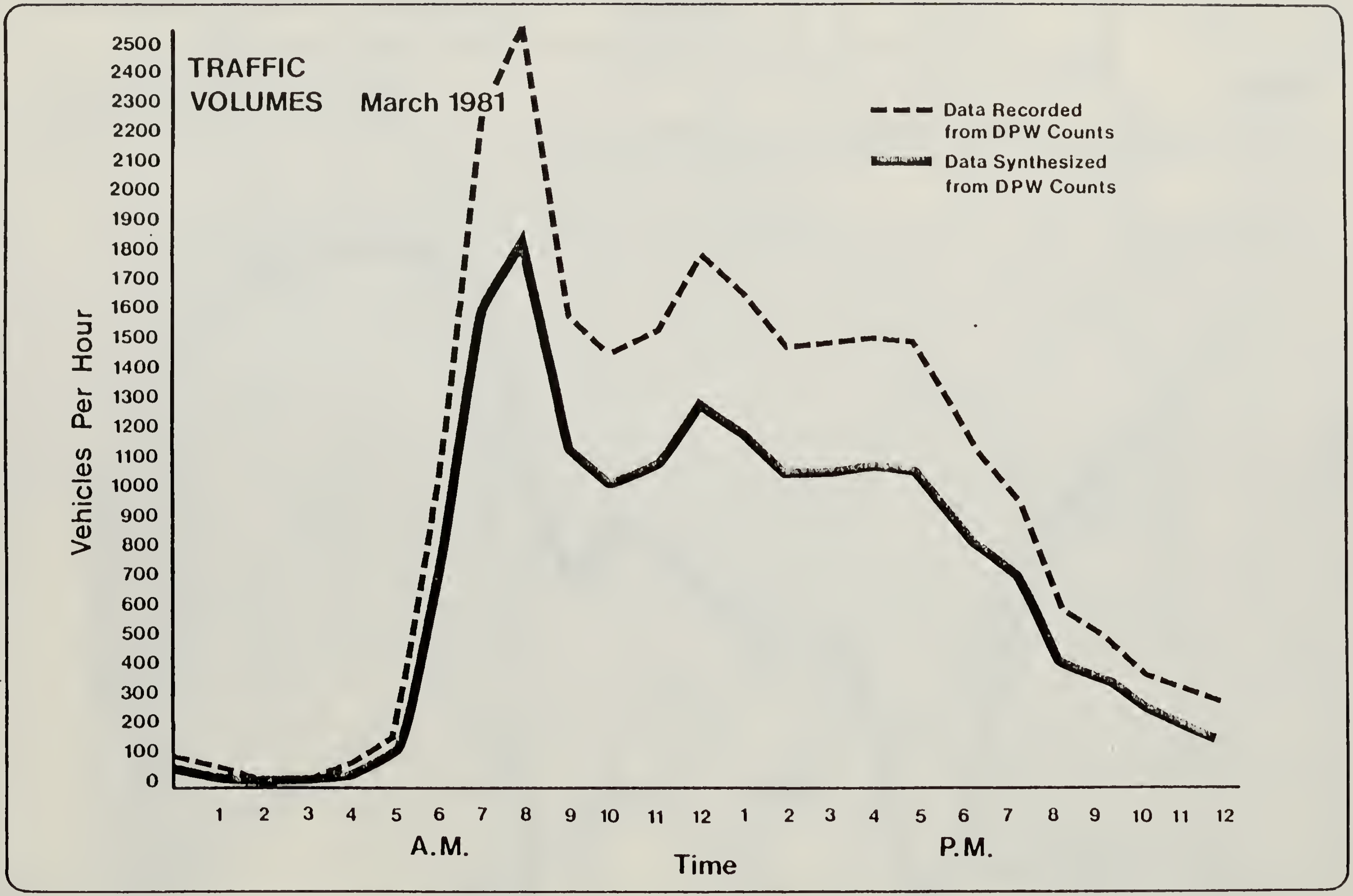


24 HOUR TRAFFIC PATTERNS

HIGHLAND AVENUE BETWEEN 1ST AND 2ND AVENUES

NEWTON-NEEDHAM RACM's STUDY

FIGURE 5

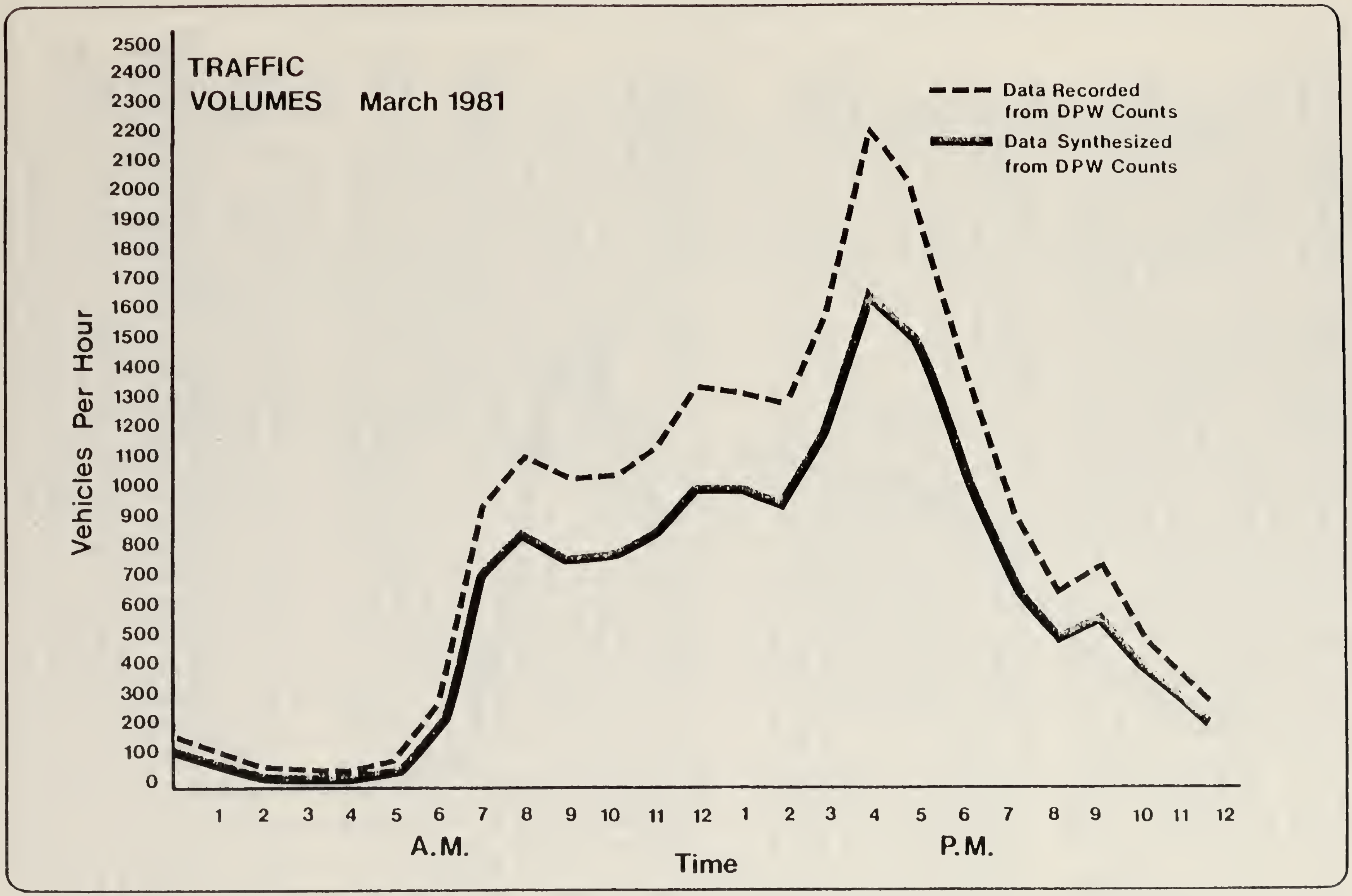


24 HOUR TRAFFIC PATTERNS, MDPW AND FACTORED COUNTS

HIGHLAND AVENUE AT SECOND AVENUE, NORTHBOUND

NEWTON-NEEDHAM RACM's STUDY

FIGURE 6



24 HOUR TRAFFIC PATTERNS, MDPW AND FACTORED COUNTS

HIGHLAND AVENUE AT SECOND AVENUE, SOUTHBOUND

NEWTON-NEEDHAM RACM's STUDY

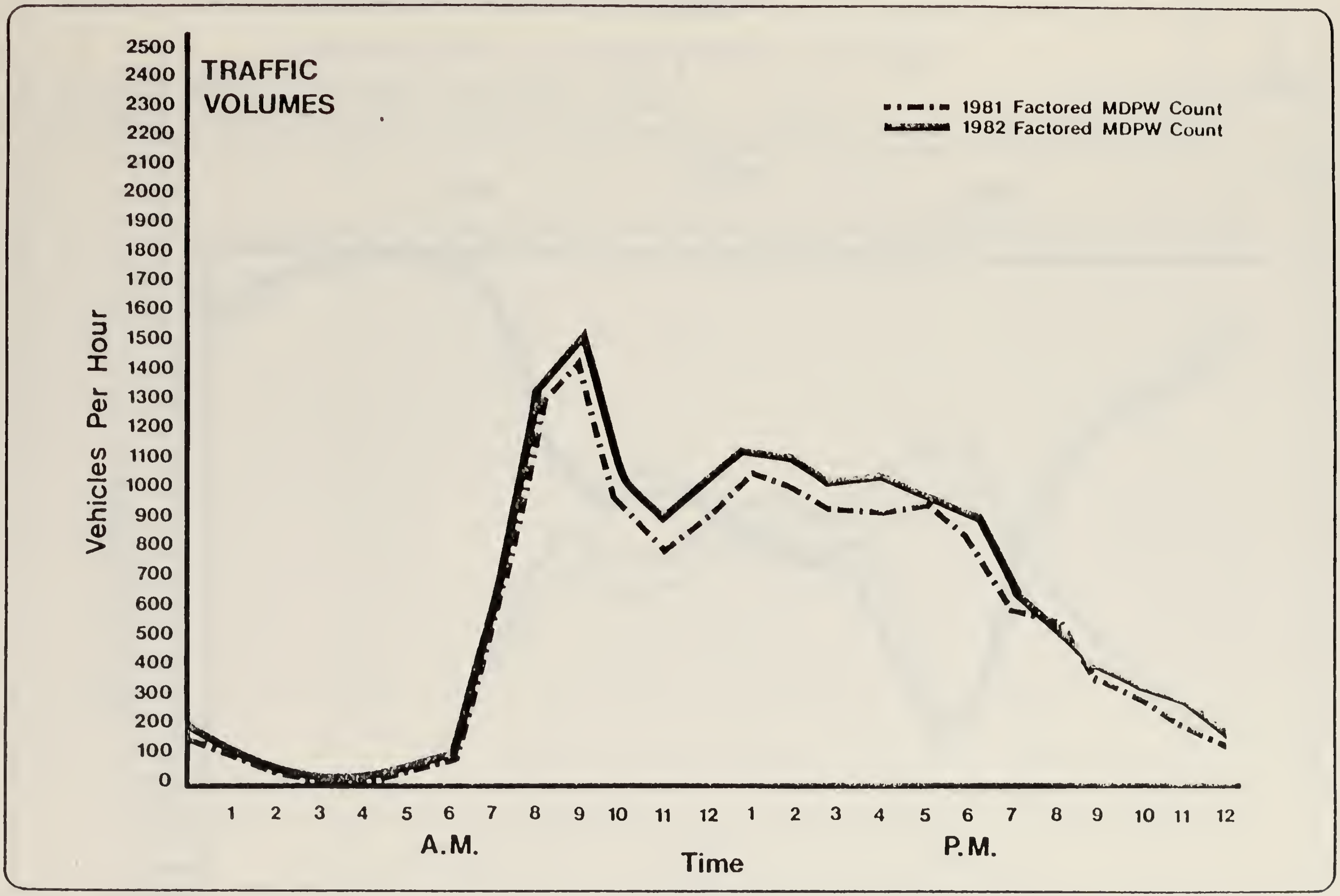
FIGURE 7

If successful, the ridesharing program was expected to reduce street traffic by increasing the number of people per vehicle traveling to and from this industrial area. To assess the program's impact on Highland Avenue traffic, 1981 and 1982 factored traffic counts were compared. The plots of 1981 and 1982 northbound traffic are shown in Figure 8. Southbound traffic is plotted in Figure 9. These plots suggest that between 1981 and 1982, there was a significant increase in northbound traffic. Average weekday traffic (AWDT) increased by roughly 7 percent. The increase in southbound traffic is less significant; AWDT increased by only one percent. The AWDT data are given in Tables 1 and 2 of Appendix 15.

On first examination, these data appear to suggest that the ridesharing program had little or no effect on local traffic. However, this conclusion is not warranted without an examination of other factors which help define the level of local traffic. For example, if a significant number of new jobs had been created in the study area, there would not necessarily be a decline in local traffic, even if the ride-sharing program were successful. Therefore, before reasonable inferences can be made about this ridesharing effort, changes in local employment and changes in the general level of local traffic need to be examined. The latter will be examined first.

The general or background level of local traffic cannot be separated from commutation traffic without detailed study. In the absence of this information this analysis looked at a surrogate measure of background traffic: traffic on Needham Street, south of Winchester Street. Needham Street was selected first because Needham Street in Newton is, in fact, an extension of Highland Avenue; the street changes names as it crosses the Charles River (see Figure 2). Second, land use along Needham Street is largely commercial, with some industrial and residential use, while land use along Highland Avenue is principally industrial. Consequently, an assumption was made that Needham Street traffic would be less affected by changes in industry-related travel than Highland Avenue. Consequently, Needham Street was thought to be a good index of background, i.e., non-industry-related traffic.

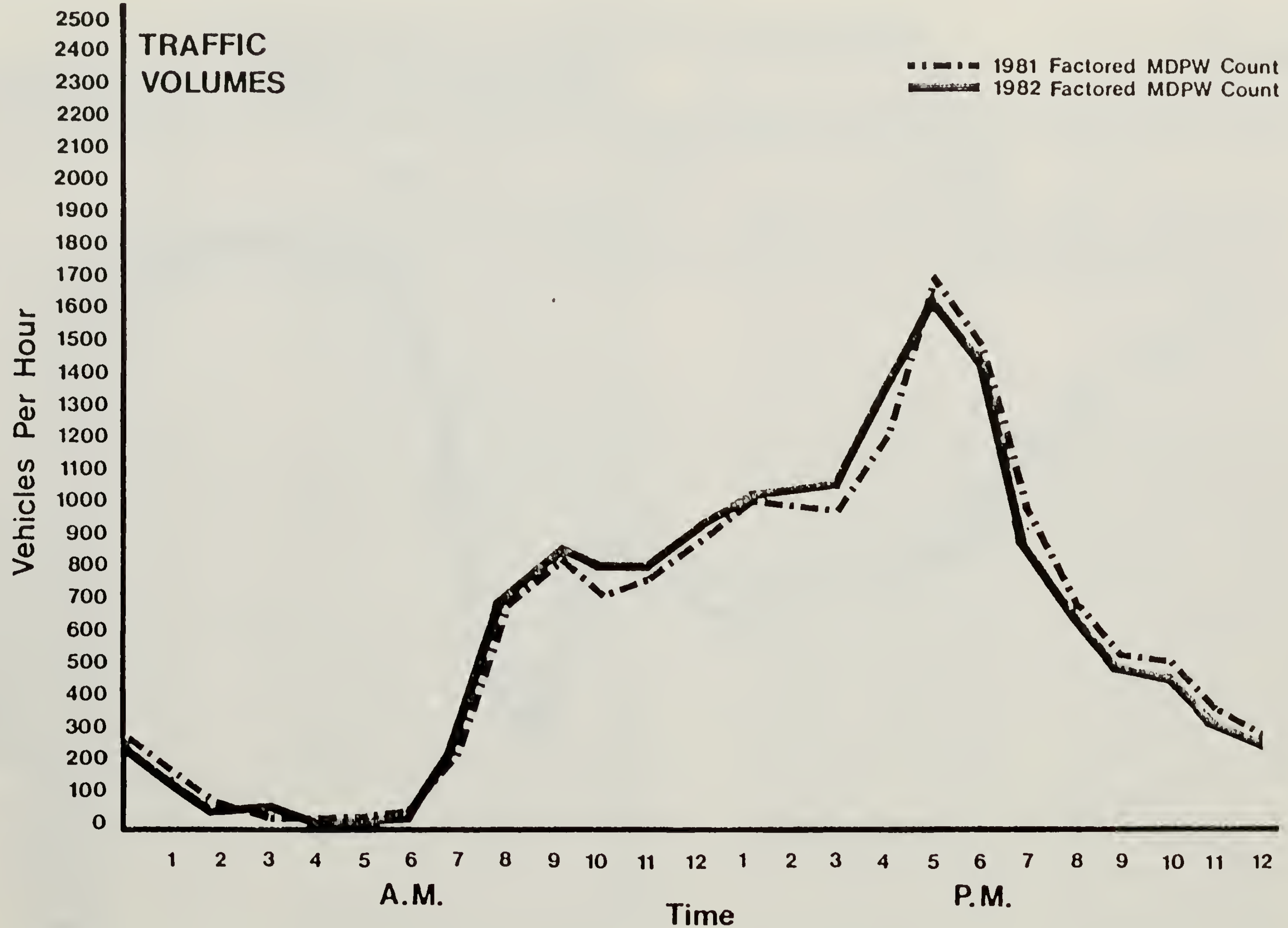
The plot of Needham Street's 1981 and 1982 traffic northbound is shown in Figure 10; southbound traffic is plotted in Figure 11. Both these graphs suggest that traffic volume increased significantly between 1981 and 1982. This conclusion is supported by the AWDT data. Tables 3 and 4 of Appendix 15 indicate that between 1981 and 1982 AWDT northbound increased 17 percent, and AWDT southbound increased 11 percent. If the previous assumption is accepted, then it appears that the level of background traffic has risen in the area. The relatively small increase in Highland Avenue traffic, 7 percent northbound and one percent southbound may then be attributable to a possible decline in the area's industrial activity.



24 HOUR TRAFFIC PATTERNS, FACTORED COUNTS
HIGHLAND AVENUE AT SECOND AVENUE, NORTHBOUND

NEWTON-NEEDHAM RACM's STUDY

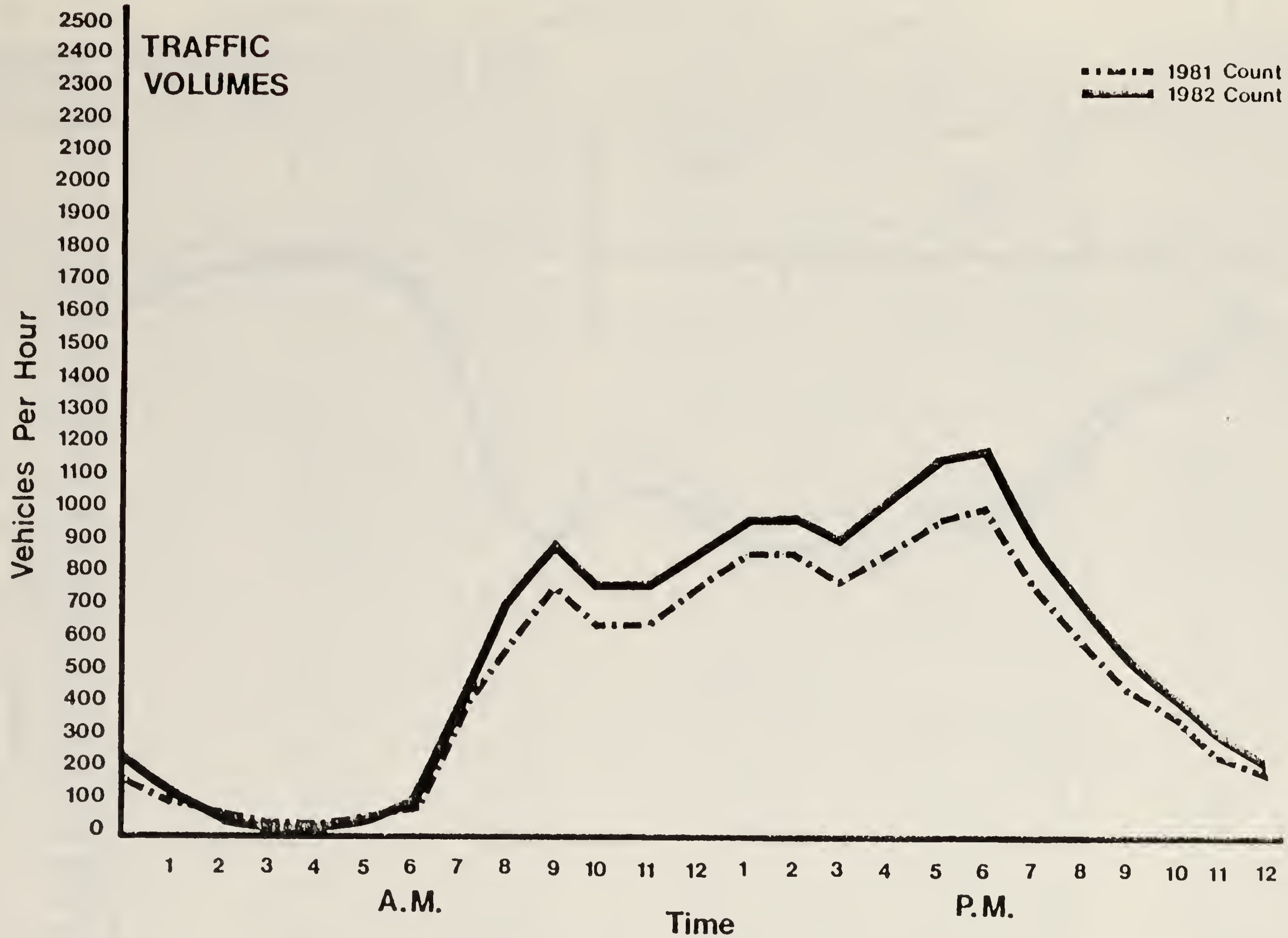
FIGURE
8



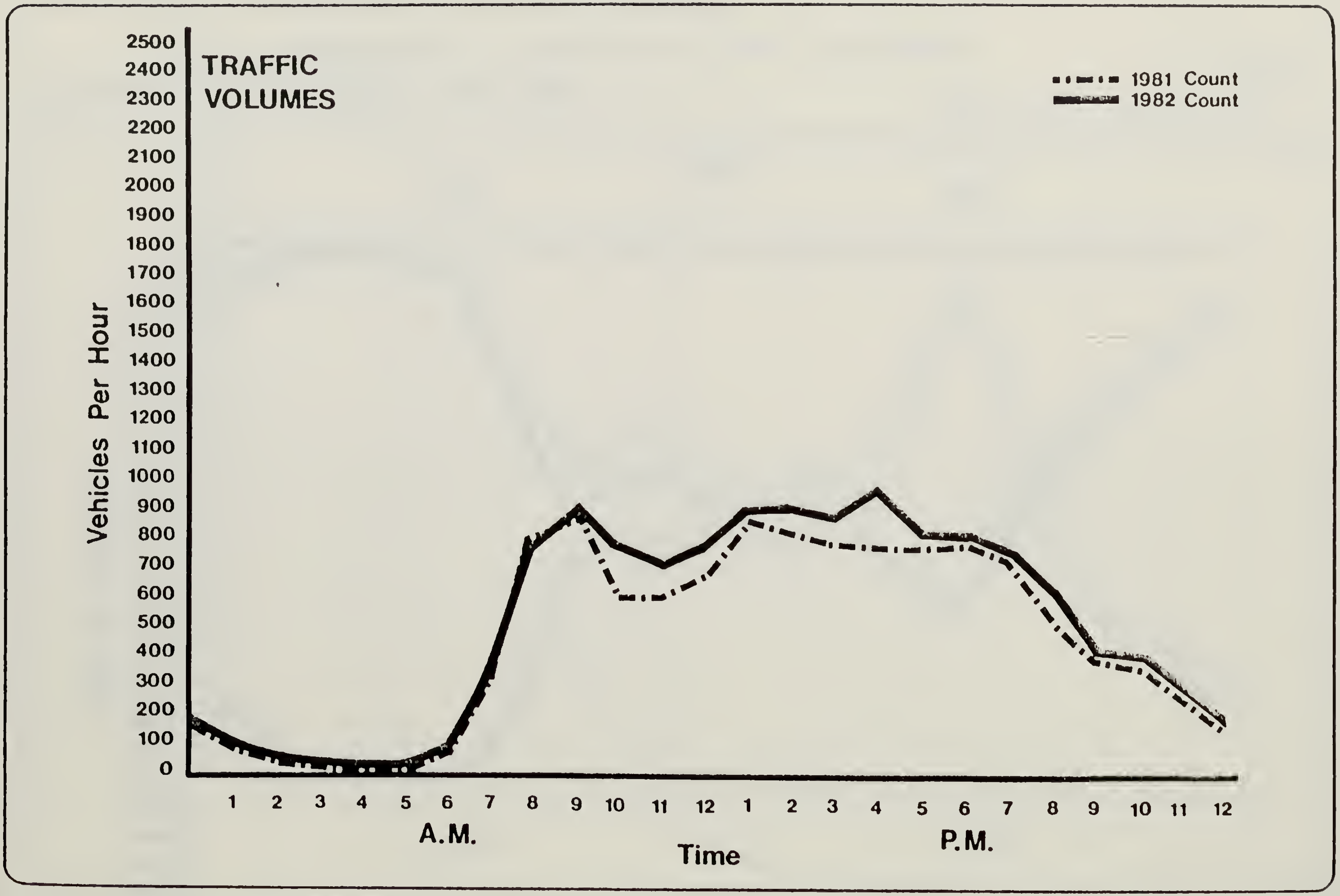
24 HOUR TRAFFIC PATTERNS, FACTORED COUNTS
HIGHLAND AVENUE AT SECOND AVENUE, SOUTHBOUND

NEWTON-NEEDHAM RACM's STUDY

FIGURE 9



24 HOUR TRAFFIC PATTERNS, MDPW COUNT NEEDHAM STREET AT WINCHESTER STREET, NORTHBOUND **NEWTON-NEEDHAM RACM's STUDY**	FIGURE 10



24 HOUR TRAFFIC PATTERNS, MDPW COUNT

NEEDHAM STREET AT WINCHESTER STREET, SOUTHBOUND

NEWTON-NEEDHAM RACM's STUDY

FIGURE 11

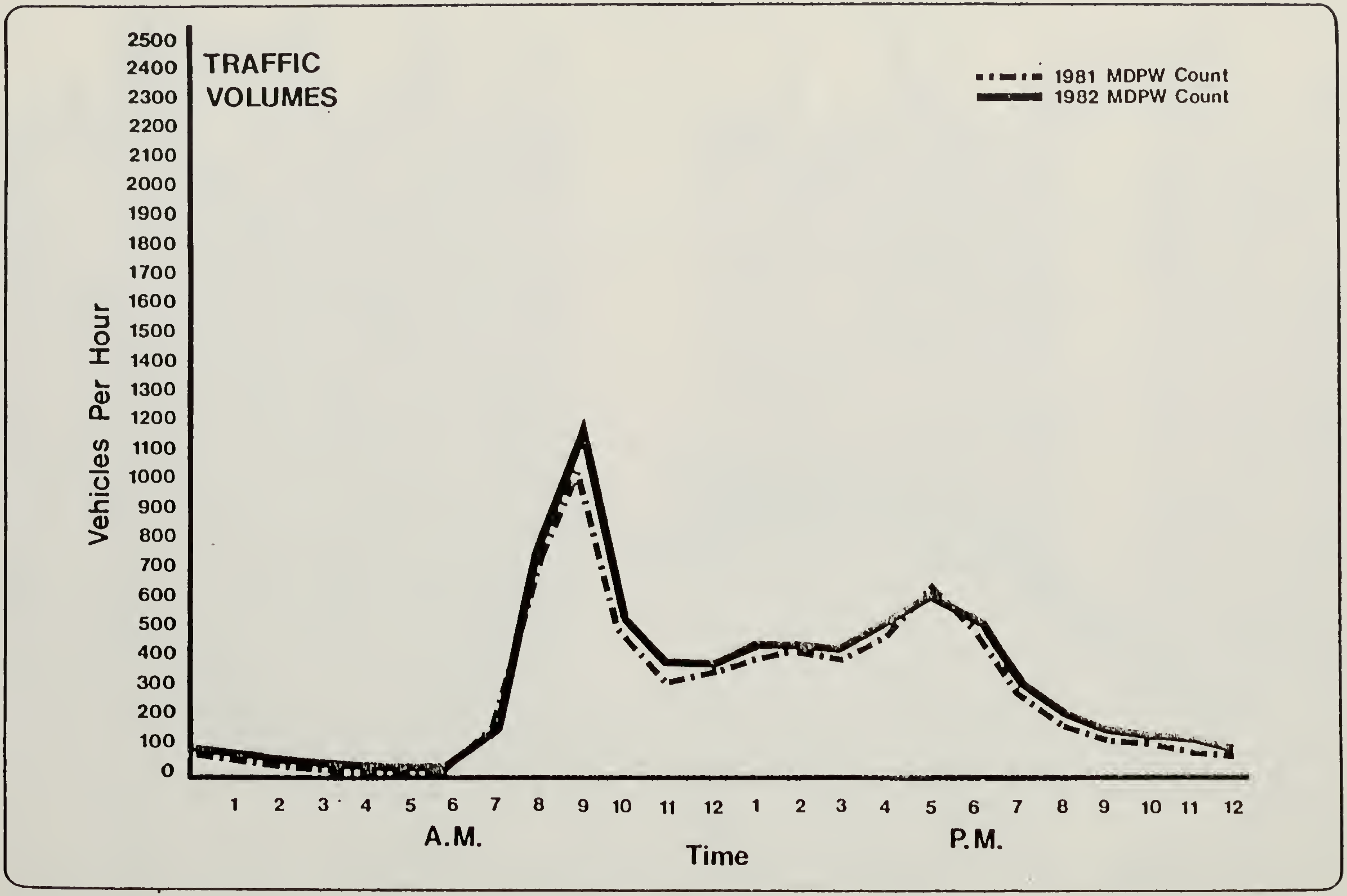
Change in the area's industrial activity is a difficult issue to quantify. An attempt was made to address this issue (see the discussion in Section E, the Employer's Survey). As this section suggests, only one firm located directly on Highland Avenue (Honeywell) was estimated to experience a significant decline in employment. Because the available information is sketchy, it is difficult to assess, quantitatively, the impact of changing industrial activity on Highland Avenue traffic. However, some estimate of probable qualitative change is appropriate.

From reports published in the Boston Globe, it is known that between March 1981 and March 1982, Honeywell experienced significant employment cutbacks in the Boston metropolitan area. It is assumed that some of these layoffs occurred at the Newton facility. Repeated efforts to identify the number of jobs lost were unsuccessful. The data in Figure 16 suggest that roughly 40 percent of the area's employees live within the area bordered by Route 128. If Honeywell's employees are distributed as the norm, then it is likely that most employees access and exit the Newton facility via Highland Avenue (to gain direct access to Route 128). The local Chamber of Commerce indicated that, beyond the Honeywell case, job losses at some firms in the area were generally offset by gains at other firms. Therefore, between 1981 and 1982 , it is probable that there was a minor decline in industry-related travel over Highland Avenue.

2. Kendrick Street

Kendrick Street appears to parallel Highland Avenue in several ways. Geographically, Kendrick Street is located just south of Highland Avenue and is the other arterial access route to the industrial park in Needham; it also serves another industrial park located in Newton. Like Highland Avenue, Kendrick Street experienced relatively small growth in traffic between 1981 and 1982. This can be seen in the graph of hourly traffic volumes in Figures 12 and 13. A comparison of 1981 and 1982 AWDT counts corroborates this finding. The data in Tables 5 and 6 of Appendix 15 indicate that eastbound traffic increased roughly 8 percent, while traffic westbound actually decreased one percent. Since Kendrick Street functions as a principal access route to two industrial parks, its modest overall growth in traffic may be attributable to stability in the number of industrial jobs in the area.

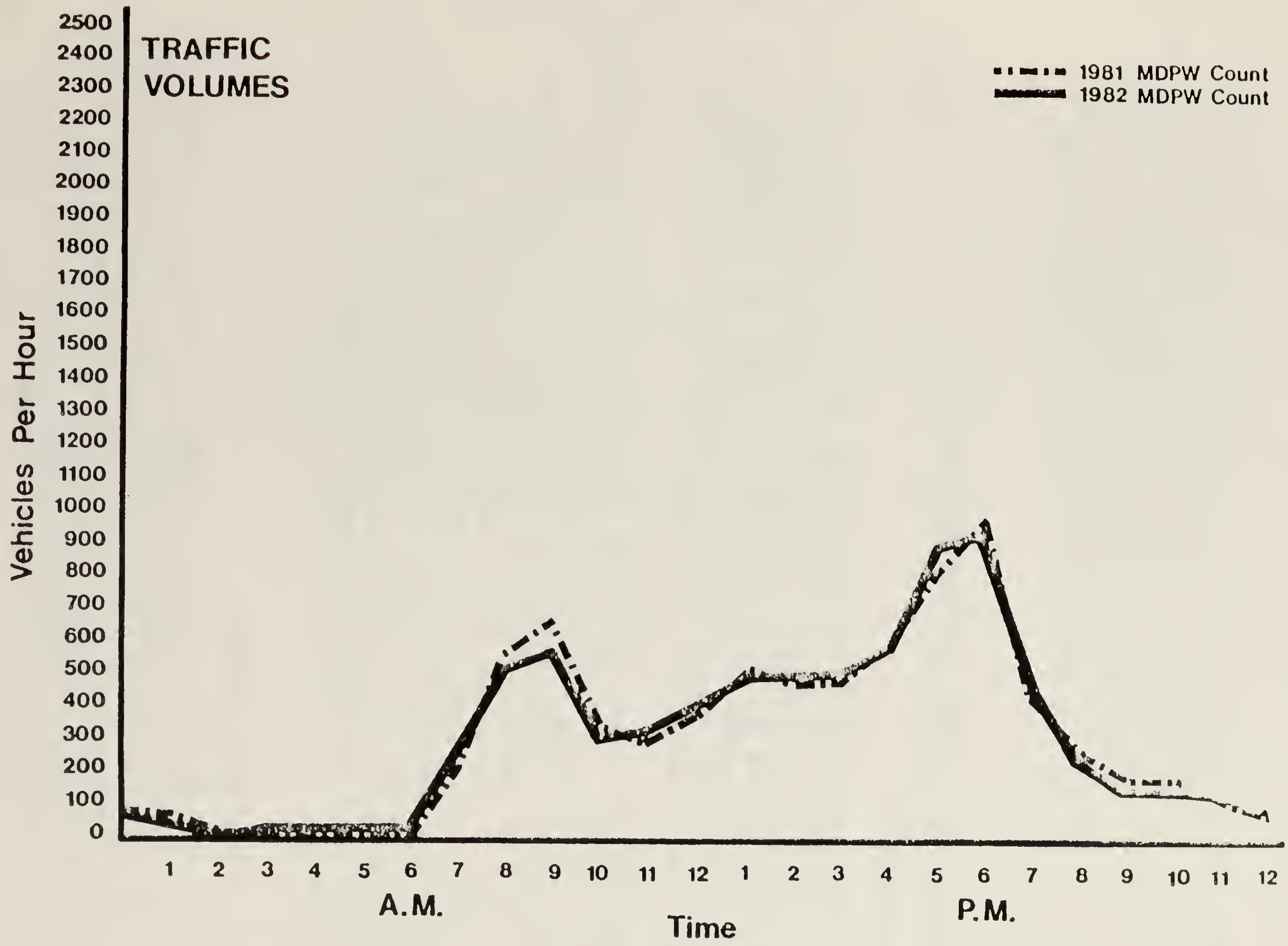
The plots of hourly traffic volume on Kendrick Street (Figures 12 and 13) suggest how this street functions. Figures 12 and 13 suggest a familiar pattern of street use. Eastbound traffic, shown in Figure 12, is characterized by a strong peaking pattern in the AM peak period, suggesting a movement off of Route 128 and toward offices and industries in the industrial area. This pattern is also characteristic of Highland Avenue northbound (see Figure 8). The complement



24 HOUR TRAFFIC PATTERNS, MDPW COUNT
KENDRICK STREET AT CHARLES RIVER, EASTBOUND

NEWTON-NEEDHAM RACM's STUDY

FIGURE 12



24 HOUR TRAFFIC PATTERNS, MDPW COUNT

KENDRICK STREET AT CHARLES RIVER, WESTBOUND

NEWTON-NEEDHAM RACM's STUDY

FIGURE 13

movement is shown in Figure 13: westbound traffic rises significantly in the AM peak period, but clearly peaks during the PM peak period. Again, there is a parallel to southbound traffic on Highland Avenue (see Figure 9), as commuters make their way from firms located in the industrial area to Route 128.

While the patterns of use are similar between Kendrick Street and Highland Avenue, the intensity of use is quite different. As mentioned earlier, the MDPW traffic data appears to overestimate observed traffic volumes on Highland Avenue. However, after adjusting Highland Avenue's volumes for this, they remain roughly 85 percent higher than Kendrick Street volumes in the AM peak hour and 75 percent higher in the PM peak hour.

3. Streets Within the Industrial Park

o First Avenue

First Avenue exhibits an unusual pattern of peak-hour use. The AM peak-hour occurs between 7:00 and 8:00 AM. There is a slight peaking at noon. However, contrary to usual patterns, there is no afternoon peak. This is caused by the lack of direct access to Route 128 (because of a traffic island on Highland Avenue, First Avenue traffic moving onto Highland Avenue must move away from Route 128).

Between 1981 and 1982, the pattern of use did not change on First Avenue. The AWDT data suggest that there was a slight increase in traffic; however, PM peak-hour traffic data indicate that, in fact, traffic declined (see Table 1). The bottom half of Table 1 presents comparable data for three manual counts performed during March 1981 and March 1982. Comparing the averages of the 1981 and 1982 manual counts, PM peak-hour traffic declined in this period. The MDPW data also corroborates this finding. Because it seems unlikely that the PM peak-hour volume would decline as the AWDT increased, the reliability of the First Avenue ATR counts is called into question.

o Third and Fourth Avenues

Third and Fourth avenues appear to function in similar ways. The morning peak period extends from 7:00 to 9:00 AM; traffic on Fourth Avenue is slightly higher than Third Avenue. Both streets experience a minor rise in traffic at noon. The PM peak period is slightly longer than the AM, extending from 3:00 to 6:00 PM. Moreover, PM peak-period volumes are a bit higher than AM peak-period volumes.

AWDT (From MDPW ATR Counts)

	1981	1982
First Avenue	6,665	6,701
Third Avenue	4,608	3,597
Fourth Avenue	5,833	5,686

PM Peak Hour (4-5, From 3-Day CTPS Manual Counts)

	Turning Movement	Vehicle Classification	Vehicle Occupancy	Average of 3 Counts	Average MDPW ATR Count
First Avenue					
1981	401	521	409	443	420
1982	407	397	387	397	417
Third Avenue					
1981	576	576	591	581	903
1982	471	492	518	494	572
Fourth Avenue					
1981	504	623	571	566	714
1982	470	492	517	493	552

TABLE 1

AWDT DATA AND A COMPARISON OF PM PEAK-HOUR MANUAL COUNTS WITH ATR COUNTS

As with First Avenue, the pattern of use did not change on Third or Fourth Avenue between 1981 and 1982. For both streets, the AWDT counts and the manual counts indicate that traffic declined in this period. The scale of the decline is in question. Looking again at the bottom half of Table 1, the manual counts suggest a more modest decline than the ATR counts. Given the consistent problem with the ATR counts, the modest decline seems more reasonable than the alternative.

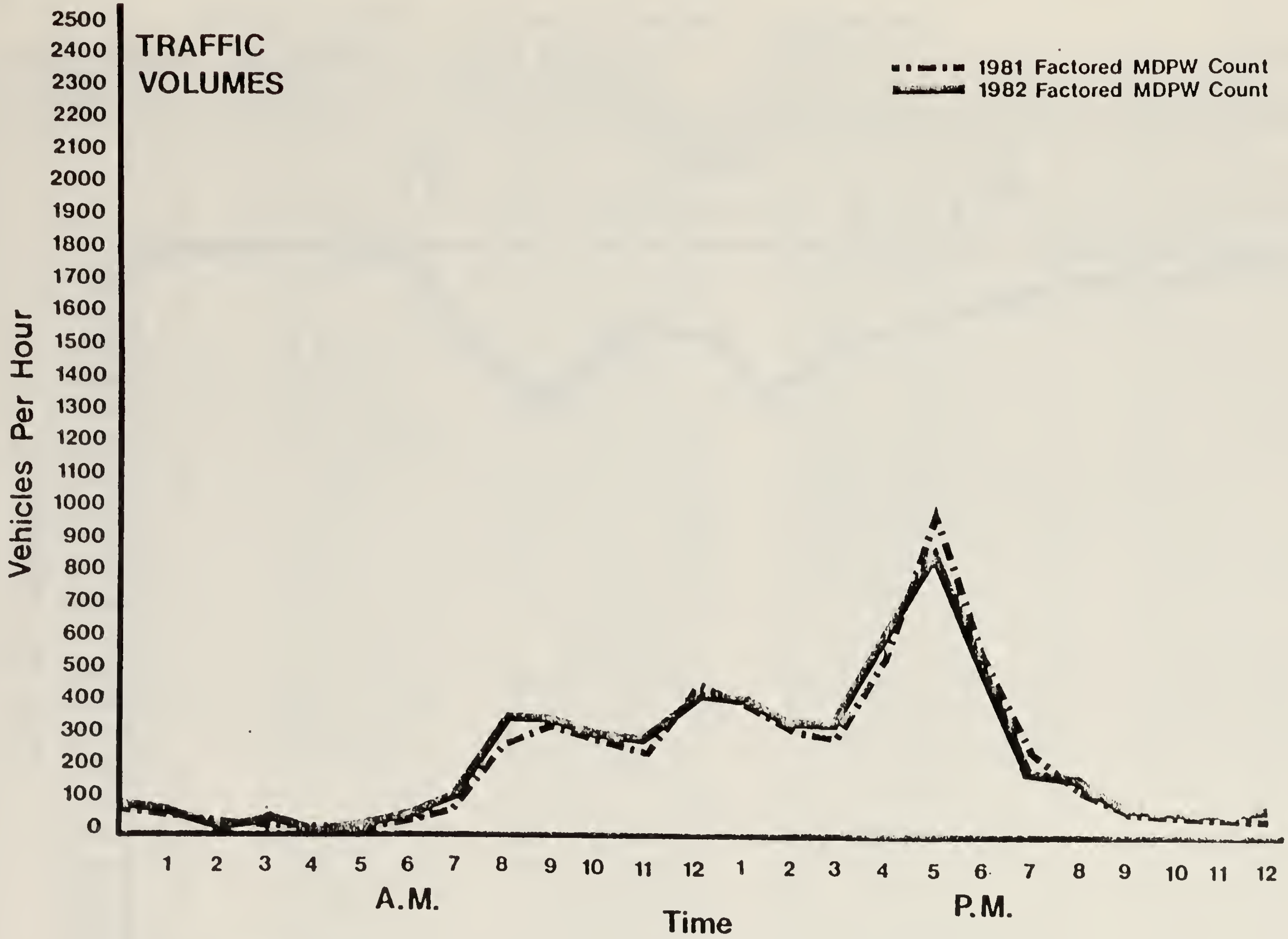
o <u>Second Avenue</u>

The plots of hourly traffic volumes are presented in Figures 14 and 15, northbound and southbound, respectively. These plots suggest that Second Avenue functions as a major access route to the New England Industrial Park. Morning peak and noontime traffic volumes are as one might expect. By contrast, afternoon peak-hour traffic volume northbound is extremely high. As shown in Figure 14, the average PM peak-hour traffic volume is approximately one-third higher than the average AM peak-hour volume. This pattern is notably different from those of the other surface streets in the industrial park. On Third and Fourth avenues, the afternoon peak-hour traffic volume is slightly higher than morning peak-hour volume (correcting for the longer PM period).

There is at least one obvious explanation for this difference in use intensity. Second Avenue is the single direct access road from the New England Industrial Park to Route 128. As mentioned earlier, left turns are not permitted from First Avenue onto Highland Avenue. Also, the Second Avenue/Highland Avenue intersection--the only signalized intersection in the industrial park--permits relatively unencumbered and frequent left turns.

The graphs presented in Figures 14 and 15 represent factored counts. That is to say, the MDPW ATR counts appeared to overestimate actual traffic on Second Avenue. Consequently, the ATR volumes were factored down. Since manual counts on Second Avenue were available only for the PM peak period, the ATR PM peak volumes were factored down to an observed volume. This proportionality, between ATR and observed volumes, was assumed to be constant throughout the day. Tables 7 and 8 of Appendix 15 present both the ATR and factored hourly traffic volumes; AWDT, based on factored volumes, are also presented.

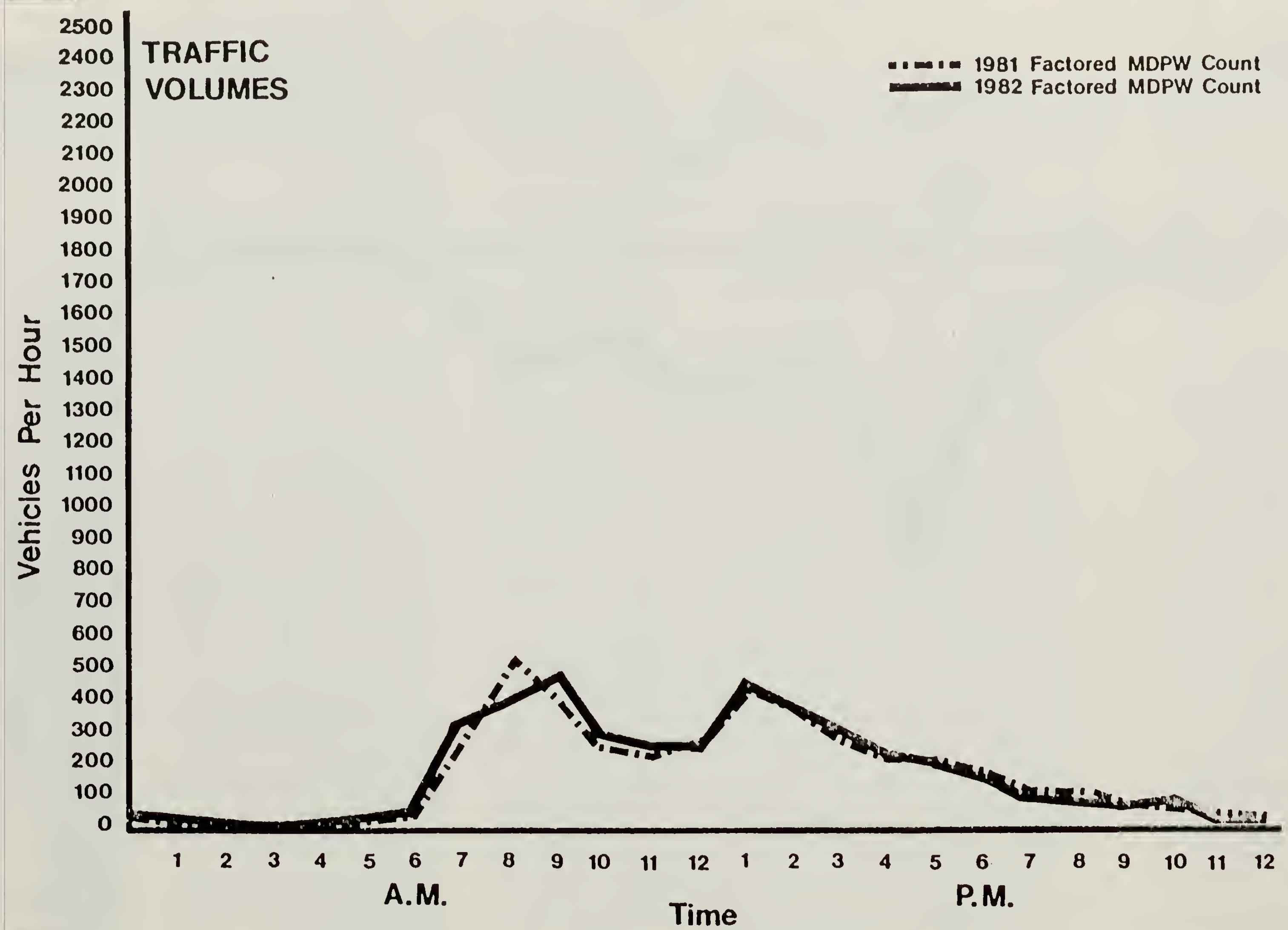
The plots in Figures 14 and 15 indicate that there was no significant change in the pattern of use. Interestingly, both the AM and PM peak-hour volumes declined between 1981 and 1982. In spite of these peak-hour declines, AWDT rose nominally during this period. Northbound traffic increased by one percent, and southbound rose by 0.5 percent.



24 HOUR TRAFFIC PATTERNS, FACTORED COUNTS
SECOND AVENUE AT HIGHLAND AVENUE, NORTHBOUND

NEWTON-NEEDHAM RACM's STUDY

FIGURE 14



24 HOUR TRAFFIC PATTERNS, FACTORED COUNTS
SECOND AVENUE AT HIGHLAND AVENUE, SOUTHBOUND

NEWTON-NEEDHAM RACM's STUDY

FIGURE 15

b. Second Avenue and Highland Avenue Level of Service

As noted above, the intersection of Second and Highland avenues experiences higher PM peak-hour traffic volume than do the other access streets of the New England Industrial Park. This appears to be the case, because the Second Avenue/ Highland Avenue intersection is the exit most directly accessible to Route 128 from the industrial park, and the intersection is the only signalized, industrial park exit. An obvious consequence of the extreme PM traffic volume is local congestion, especially along Second Avenue.

To assess the seriousness of this problem, a level of service (LOS) analysis was performed as part of this study. The method of study was based on the "Intersection Capacity Analysis" manual, formulated by the staff of CTPS. This method draws on established modes of analysis, specifically the 1965 Highway Capacity Manual (Highway Research Board Special Report 87, 1965) and Capacity Analysis Techniques for Design of Signalized Intersections by Jack E. Leisch (originally published in Public Road Magazine, September 1967). The analysis evaluated all three legs of the "T" intersection: Highland Avenue northbound and southbound, and Second Avenue northbound.

The results of this analysis on March 1981 traffic will be discussed first. (The worksheets used to develop this case are presented on pages 1 and 2 of Appendix 16.) There appears to be no congestion problem on Highland Avenue at Second Avenue, even during the peak of the afternoon commuting period. According to calculations based on manual counts, traffic on Highland Avenue operates at LOS "A." That is to say, northbound and southbound traffic on Highland Avenue moves at a free flow between 4:30 and 5:30 PM--the peak hour.

However, traffic flow on Second Avenue operates at LOS "E." This service rating is the lowest possible; it represents a forced flow condition. It can be assumed that at LOS "E," Second Avenue traffic will not clear the intersection during its green phase of the traffic cycle. Queuing can be expected as a consequence. In fact, sizable queues were observed on Second Avenue during a significant portion of the PM peak period.

During March 1982, manual counts were again performed on all three legs of the Second Avenue/Highland Avenue intersection. These data were used to establish LOS ratings at the intersection following implementation of the ridesharing program. (The worksheets used to develop this case are shown on pages 3 and 4 of Appendix 16.)

This second analysis suggested that, as was the case a year earlier, during the peak of the PM commuting period, traffic on Highland Avenue, both northbound and southbound,

operated at LOS "A." Stated another way, there was no apparent traffic problem along Highland Avenue at its intersection with Second Avenue. Also parallel to the 1981 case, PM peak-hour traffic on Second Avenue operated at LOS "E," the forced flow condition.

Contrary to expectation, PM peak-hour traffic on Second Avenue did not decline between 1981 and 1982 in spite of the ridesharing program. In fact, traffic increased slightly during this period. However, the increase was minor--less than 3 percent. Given the limited number of data points used to calculate PM peak-hour traffic, it is possible that this difference might be due to random variation in local traffic conditions.

It should be noted that these LOS ratings were calculated for the worst conditions of the day. As figures 8, 9, 14, and 15 attest, hourly traffic volumes vary widely, even within the PM peak period. However, this variance does not negatively affect Highland Avenue LOS. This is so because all other things being equal, LOS improves as traffic volume decreases. Since Highland Avenue traffic volume declines as observations move off the PM peak hour, LOS tends to improve at times other than the peak hour. In this case, this improvement is more theoretical than actual, since Highland Avenue operates at LOS "A" even during the PM peak hour.

Second Avenue traffic volume also tends to decrease at times other than the peak hour, 4:30-5:30 PM. However, this variance does affect LOS. If traffic data for the period from 3:30-4:30 PM is examined, traffic on Second Avenue northbound was calculated to operate at LOS "D" in 1981 and level "C" in 1982. During the peak hour, Second Avenue LOS was calculated to be "E" for both years. In general, LOS on Second Avenue is at or near acceptable levels prior to the PM peak hour and deteriorates to level "E" during the peak. The MDPW data in Figures 14 and 15 indicates that traffic volume falls off rapidly after the peak hour. Because of this, it is likely that LOS rises soon after the end of the PM peak hour.

By adjusting the operation of the traffic signal at this intersection, PM peak-hour congestion on Second Avenue northbound can be mitigated. This conclusion follows from the LOS worksheets labeled 16-5 in Appendix 16.

There exist a variety of specific changes which would improve Second Avenue's traffic flow. For example, by increasing the signal's total cycle length from 55 to 70 seconds, and by allocating 28 seconds of green interval to traffic on Highland Avenue and 32 seconds to Second Avenue traffic, LOS on Second Avenue can be improved slightly, from LOS "E" to "D."

This change would concurrently degrade LOS on Highland Avenue southbound from LOS "A" to "B." There would be no LOS change on Highland Avenue northbound.

The change cited here is only one example of the type of operational change which would improve traffic operation on Second Avenue. This improvement was made at marginal cost. While LOS on Highland Avenue southbound fell from "A" to "B," level "B" is considered to be a stable flow condition. Other similar operational adjustments could be made, and the example offered here is meant to be indicative of the kind of short-range change which might be considered to improve local traffic operation.

c. Travel Patterns in the Newton/Needham Industrial Area

1. Highland Avenue/Needham Street

Highland Avenue in Needham and Needham Street in Newton are, in fact, the same street. The name changes as the street passes over the Charles River. That fact notwithstanding, the street functions in significantly different ways, depending upon location.

There is an obvious difference between the pattern of street use on Highland Avenue at Second Avenue and the pattern on Needham Street at Winchester Street (compare Figures 8 and 9 with Figures 10 and 11). Highland Avenue, in the vicinity of Second Avenue, clearly functions as a traffic collector for Route 128. The intense peaking, shown in Figures 8 and 9, demonstrates this. Traffic moves from Route 128 in the morning peak, northbound on Highland Avenue, and into the surrounding industries and offices. In the PM peak, this pattern is reversed.

Traffic on upper Needham Street does not follow this pattern. In fact, northbound traffic achieves a minor peak in the afternoon, rather than in the morning. Moreover, there is no intense peaking pattern at any time of day. Instead, traffic volumes appear to rise at the start of the business day and flux relatively little until its end, when traffic declines steadily over several hours. From this pattern of use, shown in Figures 10 and 11, it appears that upper Needham Street principally serves the many commercial businesses along its length.

Highland Avenue and Needham Street also differ in use intensity as well as pattern of volumes, as shown in Figures 8, 9, 10, and 11. The MDPW data suggest that in 1981, AM peak-hour traffic on Highland Avenue was as high as 2,600 vehicles per hour, but on Needham Street only as high as 1,000 vehicles per hour. The average daily traffic (ADT) counts from these MDPW data suggest that ADT on Highland Avenue is nearly twice that on Needham Street.

As noted earlier, the MDPW PM peak data for Highland Avenue have been shown to overestimate actual hourly traffic counts. However, adjusting for this, 1981 Highland Avenue peak-hour travel is still roughly 1.8 times the PM peak-hour travel on Needham Street. This difference was yet more pronounced in 1982. This estimate of the difference should be thought of as a low bound, since the MDPW volumes for Needham Street used in this comparison may also be higher than actual volumes.

As a last comment, the patterns of street use discussed above did not change significantly between 1981 and 1982. This can be seen by comparing the plots of hourly traffic volumes presented in Figures 8, 9, 10, and 11. In general, 1982 traffic volumes were higher than those of 1981, but the 1982 distribution followed the 1981 pattern.

2. Kendrick Street

To reiterate a point made in the discussion of peak-hour traffic patterns, Kendrick Street largely parallels the function of Highland Street. Kendrick Street serves as a collector to Route 128. During the morning peak period, traffic moves predominantly eastward: from Hunting Road and Greendale Avenue (both of which end within a few hundred feet of Route 128 access ramps) onto Kendrick and then into local offices and industries. In the PM peak, the pattern reverses.

Based on the MDPW data, this pattern of street use did not change between 1981 and 1982. Figures 12 and 13 present the relevant data. As these graphs show, the patterns of distribution are nearly identical.

3. Streets within the New England Industrial Park

The pattern and intensity of street use on all streets are as one might expect on surface streets within an industrial park. All streets experience a strong rise in traffic into the industrial park as the business day begins. There is a relatively small rise in traffic volume at noontime. During the afternoon peak-hour period, there is some anomalous traffic activity. Traffic on First Avenue does not rise because there is no direct access to Route 128 from First Avenue. By contrast, traffic volume on Second Avenue is high, as Second Avenue provides the most direct access to Route 128 from the industrial park. Traffic on Third and Fourth avenues increases, as would be expected. Traffic on all streets falls off rapidly after 7:00 PM.

As with other streets in the area, the pattern of use remained the same between 1981 and 1982. The persistence of pattern can be seen for Second Avenue in Figures 14 and 15.

The MDPW hourly traffic volumes for the three other access streets in the industrial park also indicate no significant change in the pattern of street use.

d. <u>Metropolitan Commutation Patterns to the Newton-Needham Industrial Area</u>

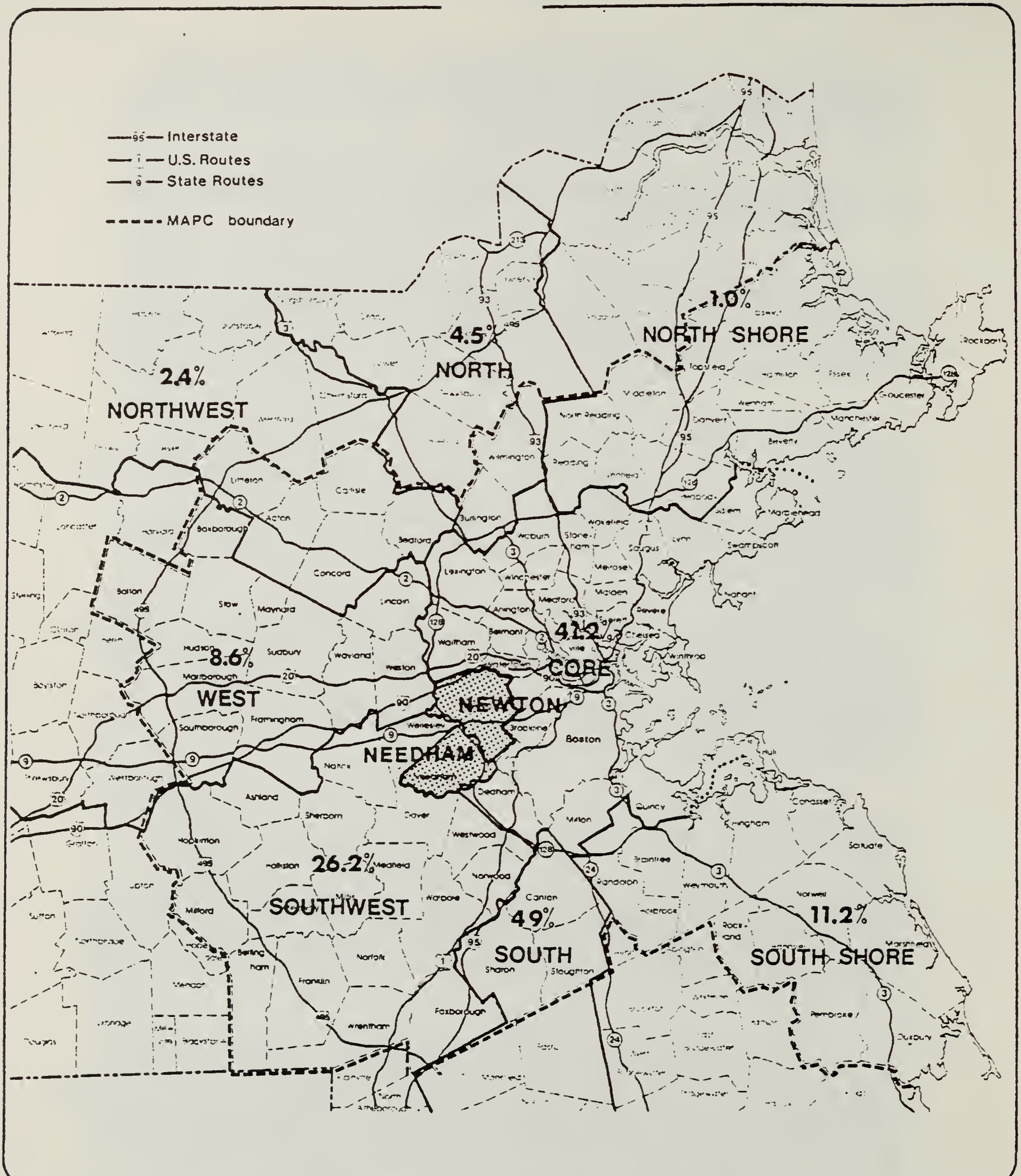
The Needham Street/Highland Avenue area attracts many work- and shopping-related trips, because of its high concentration of commercial and industrial establishments. As of late 1979 when a detailed count was last made, there were 78 office and similar establishments, 67 wholesale and retail outlets, and 25 factories and restaurants in the corridor.

A trip origin survey was a critical component of this ridesharing project. All project participants were asked to identify the location of their home in the registration survey form. It was these locations which formed the principal basis for rideshare matching, as all participants shared a common destination. A total of 754 employees at 15 companies located in the Newton-Needham industrial area completed and returned a survey form.

The home location data was handled in two ways. All respondents were asked to provide the name of the city or town in which they resided. They were also asked to locate their home on a map of the Boston metropolitan area. On this map had been imposed a grid with numbered rows and columns. It was by this grid, creating uniquely numbered zones, that home locations were also identified.

All home locations for all trips to the industrial area were compiled into density matrices. Each matrix graphically represented the travel patterns to and from the industrial area. For purposes of analysis, two general matrix types were generated. The first type represented a summation of all trips to the area and from the area, regardless of arrival or departure time. The second type represented trips to and from the area, but these trips were grouped into 15-minute arrival and departure intervals to permit an assessment of trip-making over time.

The first matrix, the cumulative matrix, served as the basis for assigning all trips to corridors. All home zones were assigned to one of eight corridors. These corridors are identified in Figure 16. This cumulating process identified the distribution of home-based work trips to the industrial area, also shown in Figure 16. There are two notable aspects of this distribution. First, roughly 40 percent of area employees live within Route 128. Second, just over one-fourth of area employees reside in the southwest corridor. Considering general residential densities, the pattern of distribution appears to be random over all corridors.



0 4 8
Scale in Miles

TRAVEL SECTORS

NEWTON-NEEDHAM RACM's STUDY

FIGURE 16

The second set of matrices revealed that AM arriving trips were more densely grouped than the PM departing trips. The distributions of AM and PM peak-period trips are presented in Tables 2 and 3, respectively. The AM trips tend to represent most of the area's arriving trips, and the PM trips represent most of the departing trips. If one examines the three, peak half-hour volumes, AM trips are heavily concentrated (37.9 percent) in one, half-hour interval and fall off rapidly after that. PM trips are distributed much more evenly. Again, looking at the three, peak half-hour volumes, PM trips are distributed quite evenly, i.e., approximately 25 percent per interval.

These data suggest that, while flexible working hours tend not to be the policy of most businesses in the area, some informal staggering of departure times seems to be practiced. This may be more true because PM peak travel and congestion tend to be more intense than those of the AM peak.

3. VEHICLE SPEED

Ambient air quality depends on several principal variables. Vehicles speed is one of these. For that reason, data has been collected on vehicles speeds on Highland Avenue/Needham Street and also on Kendrick Street. Vehicle speeds on streets completely within the industrial/office park were not recorded. These interior streets are short; in some instances, they are interrupted by significant curves. Thus, speeds tend to be highly variable. Moreover, movement on these streets is stop-and-go, as traffic must stop before entering either Highland Avenue or Kendrick Street, except at the signalized intersection of Second and Highland avenues.

Vehicle speeds were calculated from travel times. Travel times were recorded over measured distance along the length of Highland Avenue/Needham Street and Kendrick/Nahanton streets.

a. Highland Avenue/Needham Street

During the PM peak, vehicle speed on Highland Avenue/ Needham Street fluctuates by time of day and direction. The plots of vehicle speed are presented in Figure 17. Northbound traffic varies only a little, between 25 and 30 miles per hour (mph). The timing of relative rises and falls of speed varies between 1981 and 1982. This is not thought to be significant, since there were few data points on which to base the curves.

Southbound traffic presents a more unusual case. In both 1981 and 1982, vehicle speed varied from the low 20's to 30 mph between 3:30 and 4:30 PM. However, between 4:30 and 5:00 PM, an anamolous situation arises. In 1981, vehicle speed rose to

Arrivals

Interval	Number	Percentage	
6:00 - 6:15 AM	6	0.8	
6:15 - 6:30 AM	39	5.5	20.6%
6:30 - 6:45 AM	37	5.2	
6:45 - 7:00 AM	65	9.1	
7:00 - 7:15 AM	21	2.9	24.7%
7:15 - 7:30 AM	155	21.8	
7:30 - 7:45 AM	69	9.7	37.9%
7:45 - 8:00 AM	201	28.2	
8:00 - 8:15 AM	24	3.4	15.2%
8:15 - 8:30 AM	84	11.8	
8:30 - 8:45 AM	1	0.1	1.5%
8:45 - 9:00 AM	10	1.4	
		99.9	

DISTRIBUTION OF RIDESHARING PARTICIPANTS' ARRIVAL TIMES TO THE NEWTON-NEEDHAM INDUSTRIAL AREA

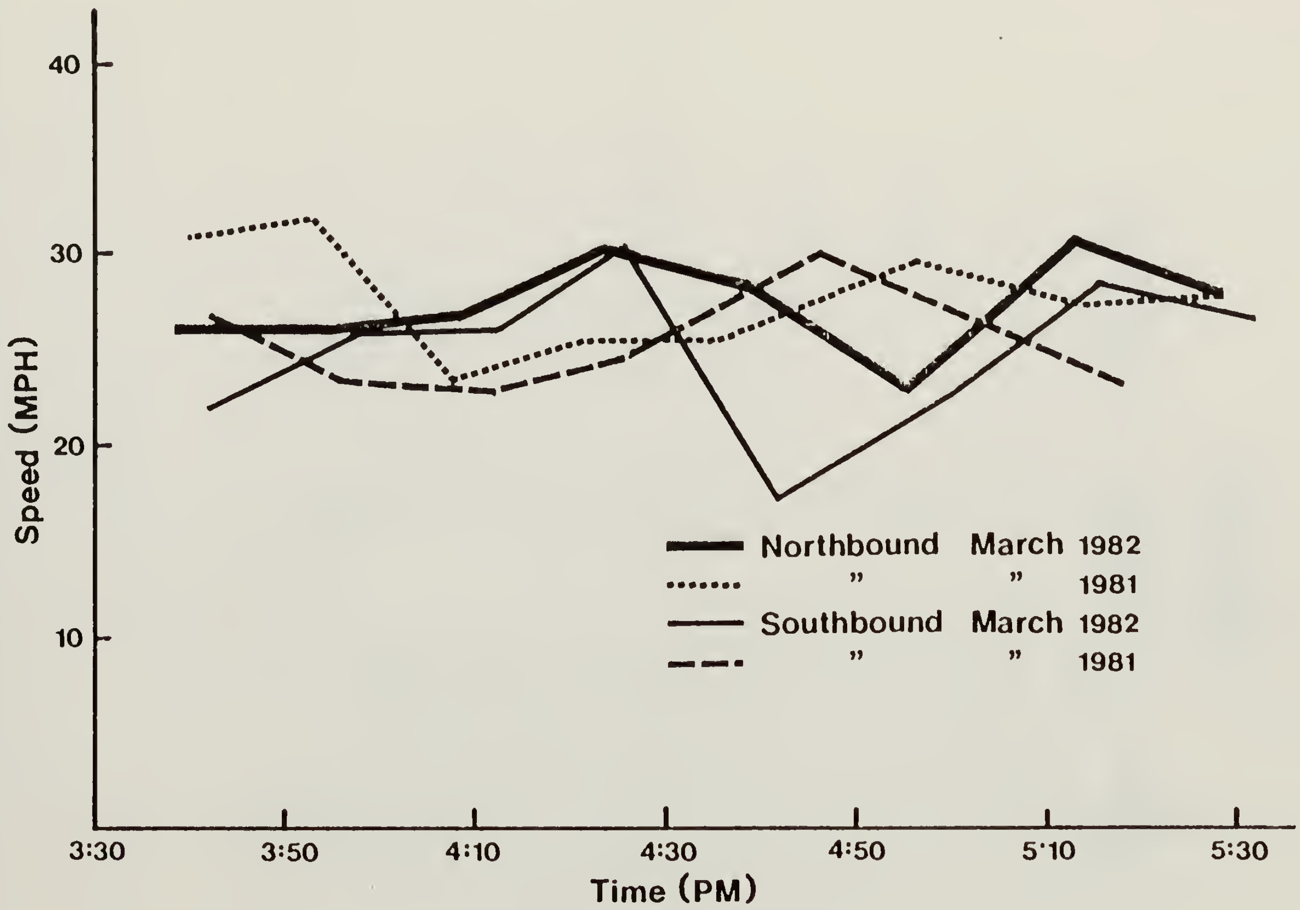
TABLE 2

Departures

Interval	Number	Percentage	
3:00 - 3:15 PM	2	0.3	11.6%
3:15 - 3:30 PM	77	11.3	
3:30 - 3:45 PM	4	0.6	23.4%
3:45 - 4:00 PM	156	22.8	
4:00 - 4:15 PM	4	0.6	26.4%
4:15 - 4:30 PM	176	25.8	
4:30 - 4:45 PM	60	8.8	27.4%
4:45 - 5:00 PM	127	18.6	
5:00 - 5:15 PM	13	1.9	11.3%
5:15 - 5:30 PM	45	6.6	
5:30 - 5:45 PM	4	0.6	
5:45 - 6:00 PM	15	2.2	
	683	100.1	

DISTRIBUTION OF RIDESHARING PARTICIPANTS' DEPARTURE TIMES FROM THE NEWTON-NEEDHAM INDUSTRIAL AREA

TABLE 3



HIGHLAND AVENUE - NEEDHAM STREET TRAVEL SPEEDS

NEWTON-NEEDHAM RACM's STUDY

FIGURE 17

a PM peak-period maximum of 30 mph; in 1982, vehicle speed fell to a peak-period minimum of 17 mph. Between 5:00 and 5:30 PM, vehicle speed tends to stabilize toward a value between 25 and 30 mph. Again, this may be a case of having too few data points to draw a representative curve.

b. Kendrick/Nahanton Streets

Travel speeds on Kendrick/Nahanton streets follow approximately the same patterns between 1981 and 1982 (see Figure 18). Eastbound traffic moves at roughly 35 mph between 3:30 and 4:30 PM. This speed falls within a few minutes, plus and minus, of 5:00 PM. The fall was more precipitous in 1981 than in 1982. By 5:15 PM, vehicle speed again rose to 35 mph.

Westbound traffic moves at roughly 30 mph between 3:30 and 4:15 PM. By 4:30 PM, vehicle speed falls to 20 mph, but again rises to 30 mph by 4:45 PM. There is some indication that vehicle speed falls again at or after 5:00 PM.

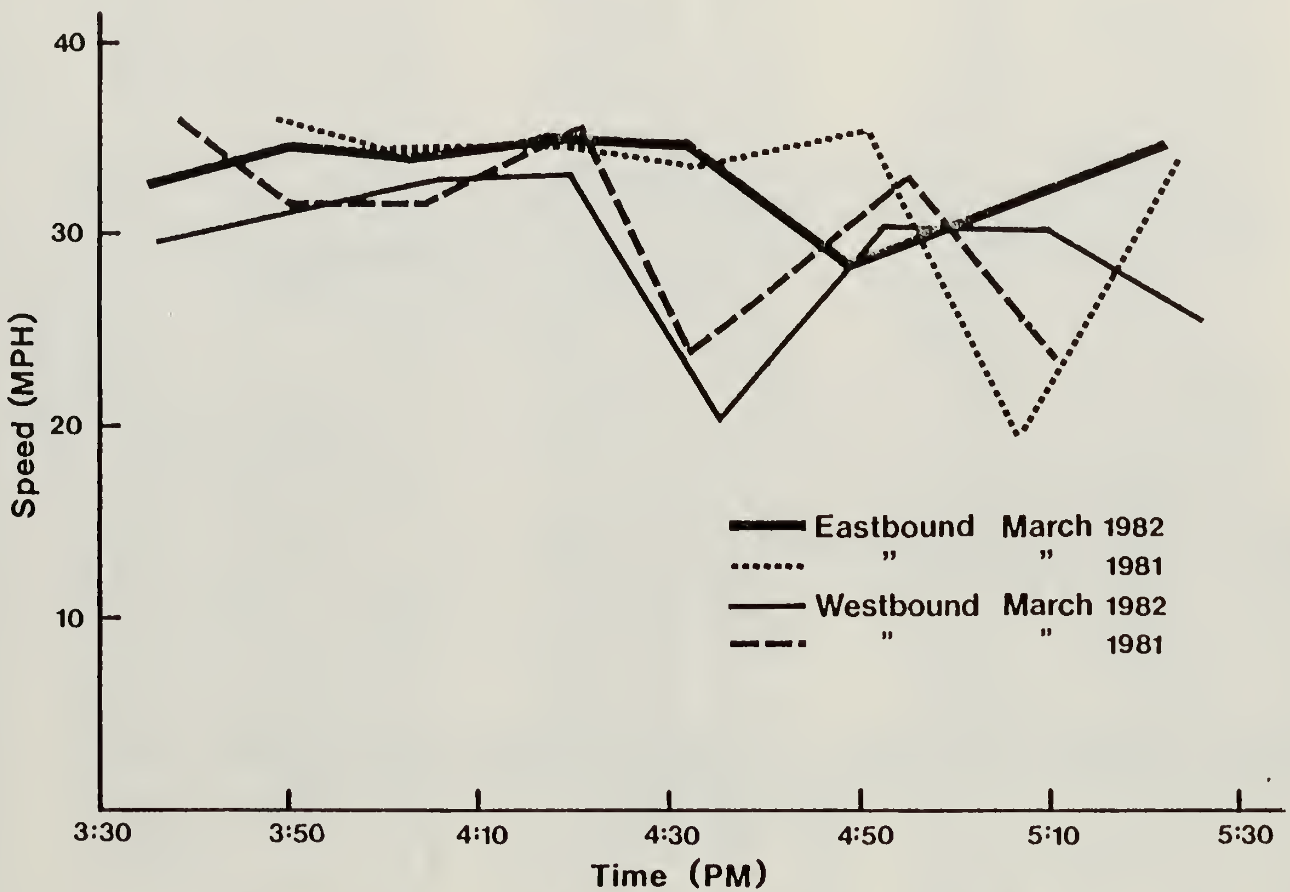
4. VEHICLE MIX

Data on vehicle mix were collected because ambient air quality is affected by vehicle mix as well as vehicle speed.

Table 4 summarizes the 1981 mix of all traffic into and out of the New England Industrial Park during the PM peak period. This table is based on data collected during March 1981. Table 5 presents these same data, but the data were collected one year later, after implementation of the ridesharing program.

The patterns of vehicle mix are remarkably similar between both sets of observations. Early in the PM peak period--between 3:45 and 4:00 PM--autos and light trucks make up 91 to 92 percent of all traffic; the balance is composed of heavy diesel trucks. As the afternoon progresses, total traffic volume rises. At the same time, the absolute number, as well as the percentage, of heavy trucks declines. This trend continues until roughly 5:15 PM, even though total traffic volume begins to decline after 4:45 PM. In general, autos and light trucks compose between 96 and 97 percent of all afternoon peak-hour traffic, while heavy diesel trucks make up the difference. Motorcycles contribute negligibly to vehicle mix.

Tables 1, 2, 3, and 4 of Appendix 17 give detailed accounts of traffic mix at the intersection of Highland Avenue and Second Avenue. These data serve primarily as input to the air quality modeling effort. It should be noted that vehicle mix on Second Avenue does not vary notably from the general pattern for the industrial park. Traffic traveling through on Highland Avenue includes fewer heavy trucks, as a percentage of all traffic, than does traffic traveling into and out of the industrial park.



KENDRICK STREET - NAHANTON STREET TRAVEL SPEEDS

NEWTON-NEEDHAM RACM's STUDY

FIGURE 18

Time (PM)	Motorcycles	Autos and Light Recreational Vehicles	Light Trucks	Two-Axle Diesel Trucks	Three and More Axle Diesel Trucks	Total 15-Minute Tally
3:45-4:00		335(80.7)	43(10.4)	25(6.0)	12(2.9)	415
4:00-4:15		506(86.3)	53(9.0)	17(2.9)	10(1.7)	586
4:15-4:30	1(0.1)*	614(89.2)	47(6.8)	14(2.0)	12(1.7)	688
4:30-4:45	1(0.1)	871(92.8)	41(4.4)	16(1.7)	10(1.1)	939
4:45-5:00	1(0.1)	653(92.5)	36(5.1)	4(0.6)	12(1.7)	706
5:00-5:15		673(92.8)	43(5.9)	6(0.8)	3(0.4)	725
5:15-5:30		493(95.4)	16(3.1)	2(0.4)	6(1.2)	517
Total Vehicle Count	3(0.1)	4145(90.6)	279(6.1)	84(1.8)	65(1.4)	4576

*All figures in parentheses represent percentage of row totals.

NEWTON/NEEDHAM RACM'S PROJECT

VEHICLE CLASSIFICATION

ALL TRAFFIC ENTERING AND EXITING INDUSTRIAL PARK, ALL SITES, 1981

TABLE 4

Time Interval (PM)	Motorcycles No.	Motorcycles %	Autos & Light Recreational Vehicles No.	Autos & Light Recreational Vehicles %	Light Trucks No.	Light Trucks %	Two Axle Diesel Trucks No.	Two Axle Diesel Trucks %	Three+ Axle Diesel Trucks No.	Three+ Axle Diesel Trucks %	Total 15 Minute Tally
3:30 - 3:45	0	-	573	(83.8)	73	(10.7)	15	(2.2)	22	(3.2)	684
3:45 - 4:00	0	-	321	(75.5)	65	(15.3)	28	(6.6)	11	(2.6)	425
4:00 - 4:15	1	(0.2)	410	(83.5)	56	(11.4)	18	(3.7)	6	(1.2)	491
4:15 - 4:30	2	(0.4)	433	(88.2)	34	(6.9)	14	(2.9)	8	(1.6)	491
4:30 - 4:45	0	-	715	(92.3)	35	(4.5)	18	(2.3)	7	(0.9)	775
4:45 - 5:00	0	-	611	(92.7)	30	(4.6)	6	(0.9)	12	(1.8)	659
5:00 - 5:15	0	-	640	(94.1)	31	(4.6)	7	(1.0)	2	(0.3)	680
5:15 - 5:30	0	-	510	(94.3)	19	(3.5)	3	(0.6)	9	(1.7)	541
TOTAL Vehicle Count	3	(0.1)	4,213	(88.8)	343	(7.2)	110	(2.3)	77	(1.6)	4,746

All figures in parentheses represent percentage of row totals.

TABLE 5

NEWTON-NEEDHAM RACM's STUDY VEHICLE CLASSIFICATION
ALL TRAFFIC ENTERING AND EXITING INDUSTRIAL PARK, ALL SITES, 1982

5. VEHICLE OCCUPANCY

Ridesharing was a significant travel mode for employees working within the New England Industrial Park in 1981. The same was true a year later, after implementation of the multi-employer ridesharing promotion. However, contrary to expectation, there was no significant change in ridesharing between March 1981 and March 1982. These conclusions are supported by manual vehicle occupancy counts performed by CTPS and MAPC staff members at the industrial park's four access points.

Tables 6 and 7 show the distributions of single- and multiple-occupancy vehicles by site in 1981 and 1982, respectively. As seen in these tables, during the PM peak period, approximately one-fifth of all vehicles moving into and out of the industrial park carry two or more occupants. This level of ridesharing appears to be the practice throughout the industrial park. The distribution on Third Avenue presents a minor deviation from the norm; here, multiple-occupancy vehicles make up approximately one-fourth of all PM peak period traffic. There is no immediately apparent explanation for this higher concentration of ridesharing on Third Avenue.

Tables 8 and 9 present summary vehicle occupancy data for all sites by 15-minute intervals in 1981 and 1982, respectively. Within the afternoon peak period, there is fluctuation in weighted average vehicle occupancy. The data in these tables indicate that weighted average vehicle occupancy ranges between 1.17 and 1.33 persons per vehicle.

There is a tendency for relatively high values to occur during intense portions of the peak period. This is more true of the 1981 than the 1982 case. The most numerous type of multi-occupant vehicle is the two-person vehicle, which makes up approximately 15 percent of all PM peak-period traffic in both 1981 and 1982. The percentage of two-occupant vehicles tends to increase as the peaking phenomenon intensifies. From the 1981 data, it is known that there is a relative peak in traffic between 3:30 and 3:45 PM. During this period, average vehicle occupancy is also relatively high in 1981 and 1982. The number of two-occupant vehicles as a percentage of all traffic is roughly 17 percent, and single-occupant vehicles are at a relative low, representing only 76 to 77 percent of total traffic. This pattern is again repeated between 4:30 and 4:45 PM. During this interval travel into and out of the industrial park is at its highest. In 1981, two-occupant vehicles made up roughly 18 percent of traffic during that interval; in 1982, they made up only 14 percent of traffic. The percentage of single-occupant vehicles increased during this interval: in 1981, they made up 76 percent of total traffic; in 1982, they represented 80 percent.

Number of Vehicles With ($x^{\#}$) of Passengers

	Number of Passengers Per Vehicle				
Site	1	2	3	4 or more	TOTAL
Site # 1	1357(80.2)*	274(16.2)	37(2.2)	24(1.4)	1692
Site # 2	3682(82.4)	620(13.9)	88(2.0)	81(1.8)	4471
Site # 3	669(73.0)	194(21.2)	34(3.7)	19(2.1)	916
Site # 4	899(82.8)	158(14.5)	20(1.8)	9(0.8)	1086
TOTAL	6607(80.9)	1246(15.3)	179(2.2)	133(1.6)	8165

*All figures in parentheses represent percentage of row totals.

NEWTON-NEEDHAM RACM'S STUDY — VEHICLE OCCUPANCY

ALL TRAFFIC ENTERING AND EXITING INDUSTRIAL PARK, ALL SITES, 1981

TABLE 6

Site	Vehicle With One Person No.	%	Vehicle With Two Persons No.	%	Vehicle With Three Persons No.	%	Vehicle With Four+ Persons No.	%	Total
First Avenue*	645	(79.5)	144	(17.8)	16	(2.0)	6	(0.7)	811
Second Avenue*	1,629	(82.1)	275	(13.9)	56	(2.8)	25	(1.3)	1,985
Third Avenue*	719	(78.6)	152	(16.6)	26	(2.8)	18	(2.0)	915
Fourth Avenue*	891	(82.1)	163	(15.0)	25	(2.3)	6	(0.6)	1,085
TOTAL	3,884	(81.0)	734	(15.3)	123	(2.6)	55	(1.1)	4,796

*All numbers in parentheses represent percentage of row total.

TABLE 7

NEWTON-NEEDHAM RACM'S STUDY VEHICLE OCCUPANCY
ALL TRAFFIC ENTERING AND EXITING INDUSTRIAL PARK, 1982

Number of Vehicles With ($x^{\#}$) of Passengers

Time Interval	Number of Passengers Per Vehicle: 1	2	3	4 or more	Total Avg. Number of Vehicles	Total Avg. Number of Passengers
2:45-3:00	228(85.7)*	33(12.4)	2(0.8)	3(1.1)	266	1.17
3:00-3:15	247(83.2)	42(14.1)	5(1.7)	3(1.0)	297	1.21
3:15-3:30	245(80.9)	49(16.2)	8(2.6)	1(0.3)	303	1.22
3:30-3:45	696(77.2)	151(16.7)	29(3.2)	26(2.9)	902	1.32
3:45-4:00	595(81.7)	111(15.2)	14(1.9)	8(1.1)	728	1.22
4:00-4:15	774(82.4)	130(13.8)	17(1.8)	18(1.9)	939	1.23
4:15-4:30	758(82.3)	137(14.9)	14(1.5)	12(1.3)	921	1.22
4:30-4:45	1030(75.7)	249(18.3)	49(3.6)	33(2.4)	1361	1.33
4:45-5:00	777(82.3)	134(14.2)	19(2.0)	14(1.5)	944	1.23
5:00-5:15	831(82.0)	156(15.4)	18(1.8)	8(0.8)	1013	1.21
5:15-5:30	426(86.8)	54(11.0)	4(0.8)	7(1.4)	491	1.17
TOTAL	6607(80.9)	1246(15.3)	179(2.2)	133(1.6)	8165	1.245

*All figures in parentheses represent percentage of row totals.

NEWTON-NEEDHAM RACM'S STUDY

VEHICLE OCCUPANCY

ALL TRAFFIC ENTERING AND EXITING INDUSTRIAL PARK, ALL SITES, 1981

TABLE 8

Time Interval	Vehicle With One Person No.	%	Vehicle With Two Persons No.	%	Vehicle With Three Persons No.	%	Vehicle With Four+ Persons No.	%	All Vehicles	Weighted Average Persons/Vehicles
3:30 - 3:45	529	(76.4)	117	(16.9)	30	(4.3)	16	(2.3)	692	1.33
3:45 - 4:00	349	(86.4)	70	(16.1)	9	(2.1)	6	(1.4)	434	1.24
4:00 - 4:15	409	(82.1)	76	(15.3)	8	(1.6)	5	(1.0)	498	1.21
4:15 - 4:30	482	(83.8)	80	(13.9)	11	(1.9)	2	(0.3)	575	1.19
4:30 - 4:45	660	(79.7)	117	(14.1)	32	(3.9)	19	(2.3)	828	1.29
4:45 - 5:00	494	(83.2)	88	(14.8)	8	(1.3)	4	(0.7)	594	1.20
5:00 - 5:15	587	(82.3)	111	(15.6)	14	(2.0)	1	(0.1)	713	1.20
5:15 - 5:30	374	(81.0)	75	(16.2)	11	(2.4)	2	(0.4)	462	1.22
TOTAL Vehicle Count	3,884	(81.0)	734	(15.3)	123	(2.6)	55	(1.1)	4,796	1.239

*All numbers in parentheses represent percentage of row total.

TABLE 9

NEWTON-NEEDHAM RACM'S PROJECT — VEHICLE OCCUPANCY

ALL TRAFFIC ENTERING AND EXITING INDUSTRIAL PARK, ALL SITES, 1982

As noted earlier, vehicle occupancy performed contrary to expectation between 1981 and 1982. The expectation was that the ridesharing promotion would stimulate the formation of more carpools in 1982 than existed in 1981. The data indicate that this did not happen. In fact, there was overall decline in average vehicle occupancy, comparing only travel that occurred between 3:30 and 5:30 PM in 1981 with the same traffic in 1982. In 1981, the weighted average vehicle occupancy of all traffic during this interval was 1.250 persons per vehicle. In 1982, this value was 1.239 persons per vehicle. The reasons for this seemingly perverse trend will be discussed in Section H.

A final note should be made concerning the connection between multi-occupant vehicles and commuting. An inference can be drawn that multi-occupant vehicles are being used for commuting purposes by examining the available data on vehicle mix. The data in Tables 4 and 5 indicate that between 4:30 and 4:45 PM--the height of the PM peak period and a relative high regarding vehicle occupancy--autos and light recreational vehicles made up 93 percent of all 1981 industrial park traffic and 92 percent of all 1982 industrial park traffic. Only 45 minutes earlier, autos and light recreational vehicles made up only 81 and 76 percent of 1981 and 1982 traffic, respectively. If it is assumed that autos and light recreational vehicles are more apt to be used for commuting purposes than are light and heavy trucks, then it can be inferred that ridesharing is a significant commuting mode in this industrial/office park area.

6. PUBLIC TRANSPORTATION

Public transportation is provided by the MBTA in the vicinity of the study area in the form of bus service, rapid transit (streetcar), and commuter rail (temporarily replaced by express bus service).

Bus service is provided by MBTA Route No. 532, which connects Needham Center with Watertown Square. The closest the route comes to the corridor is Webster Street at the western end of the corridor. Headways are 30 minutes during the morning and evening peak periods.

The New England Industrial Park was served by MBTA Route No. 170, for one trip daily from Dudley Station, until this service was discontinued in early April 1981.

Rapid transit service is provided by Green Line streetcars at the Center Street and Eliot Street stations in Newton Highlands, both of which are one half to one mile outside the study corridor.

Until October 1979, commuter rail service was provided to the area by the MBTA through the Boston & Maine Corporation. The route ran between South Station and Needham Heights (passing through Forest Hills in Boston at the end of the Orange Line). The terminus of the route was located near Webster Street at the western end of the study corridor. The headways were approximately 25 minutes during the peak periods.

On October 15, 1979, the MBTA discontinued rail service on the Needham Branch and replaced it with express bus service to downtown Boston and Back Bay (Route No. 310). During AM and PM peak periods, this service runs at headways of between 2 to 10 minutes. This replacement service will be provided during Orange Line construction activity in the Southwest Corridor--an estimated three to four years.

Additional transit service in the area is provided by the towns of Needham and Newton. Needham subsidizes a local mini-bus service called the Needham-Mite. This service is operated by Suburban Lines under contract to the town. Service routing in the study area is between Needham Center and the New England Industrial Park. The Needham-Mite travels east on Kendrick Street, turns left on Fourth Avenue, turns left again onto Second Avenue, and leaves the industrial park by turning left onto Highland Avenue. Service in the industrial park begins at approximately 7:40 AM and operates hourly until the last run at 4:40 PM. Approval for this service was renewed by the town in May 1982. Under this contract, service will be provided until the end of March 1983. Discussions are in progress concerning proposed service changes after March 1983.

In 1981 and part of 1982, local transit service from Newton was operated in a slightly different way. Newton's service was operated by Andre Coach Lines. However, only part of the subsidy necessary to operate the service had been provided by the town. Newton provided a fixed amount of start-up capital; various organizations in the private sector provided subsidy for the service on a continuing basis. Service to businesses and industries along Needham Street in the New England Industrial Park and in the Wells Avenue Office Park was provided only during the morning and afternoon peak periods. Service in the morning included three runs at roughly 45-minute headways, the first starting at 8:10 from Newton Center to the industrial/office park area and back. Afternoon service started at 4:25 and had the same route, headway, and number of runs. Service was initiated in September 1980.

As of June 1982, local bus service ended, due to low ridership. The service which replaced it provides local transit for shopping and school transport. However, the new service area does not include this study area.

G. AIR QUALITY ISSUES

1. INTRODUCTION

On February 16, 1981, DEQE submitted to the Central Transportation Planning Staff Director a copy of its proposed work effort for quantifying air quality for the Route 128 Suburban Industrial/Office Park Demonstration Project. The work program covered a two-year period and consisted of three major tasks:

1. Measurement by CO monitors in the field.
2. Determination of NMHC totals and CO levels by EPA-accepted modeling procedures.
3. Verification of CO hot spots.

The work program was designed to measure the before and after impacts of the RACM's, if any, that were to be developed and implemented during this period by CTPS/MAPC.

2. MEASUREMENT OF CARBON MONOXIDE BY MONITORS IN THE FIELD

a. Monitor Site Analysis

DEQE, in its letter of commitment to the project, requested that staff be involved in the screening of potential monitor sites. DEQE requested that its staff be given an advanced list of sites being considered by CTPS/MAPC and that they be involved in any field survey work conducted to determine the actual site. DEQE staff would then evaluate and rank the potential sites from both an air quality perspective and the ability to place monitor equipment on site.

On October 29, 1980, DEQE staff accompanied MAPC personnel on site visits to five industrial parks along the Route 128 corridor. The sites were evaluated by staff and rated based on a three-point system (1 = high, 2 = medium, 3 = low) relative to acceptability for monitoring purposes. The five categories rated were: 1) distance to and accessibility of electricity, 2) accessibility of staff to the site, 3) ease of implanting the monitor trailer, 4) setback requirements, and 5) ability to meet the minimum siting requirements for carbon monoxide. The final results were submitted to CTPS/MAPC in October 1980. The Newton-Needham Industrial/Office Park was then chosen, based on these and other criteria contained in the reconnaissance report.

b. Locating the Monitor

In late January 1981, DEQE and CTPS staff visited the Newton-Needham site in order to determine where the monitor would be placed. Three potential sites were identified at that time. Two of the potential sites were identified as property owned by a local private automobile dealership, the third site was owned by Boston Edison. The first step, as agreed by CTPS, was to contact the automobile dealer for permission to use their property. CTPS could not get the necessary permission from the dealer and, therefore, CTPS requested that DEQE contact Boston Edison. In late January, DEQE received permission from Boston Edison to place the monitor on-site. In clearing the way for placing the monitoring equipment on-site, DEQE legal staff pursued the issue of non-liability agreements. In addition, the DEQE monitoring section began the task of purchasing equipment. This task posed a problem as the minimum time required for delivery was one month, and the CO monitoring season concludes at the end of March. With great effort, DEQE was able to place the monitoring equipment on-site by early March 1981.

c. On-Site Monitoring

The DEQE operated the Newton-Needham monitor for approximately seven months during 1981 and 1982. DEQE personnel visited the site one to two times a week to check the equipment and recalibrate it. This was done to ensure accurate data collection and a high data capture. The strip charts recorded on-site were read in-house by DEQE staff in Boston and rechecked by monitoring personnel for quality assurance purposes. The data was then submitted in two separate packages: the 1981 data set summary and the 1982 data set summary. This information has been included in Appendix 18.

Measurements of the area temperature, wind direction, wind speed, and carbon monoxide levels were collected. All data collected was based on 15-minute intervals. The collection of meteorological data, in conjunction with carbon monoxide levels, allowed for a more thorough analysis of the recorded values. In analyzing the data, it was the initial intent to make correlations between the traffic and carbon monoxide information in order to determine the success of implemented reasonably available control measures in the area.

During the 1981 monitoring season, data capture totaled 28 days during the month of April. It should be noted that, although the monitor was actually on-site in early March, the start-up date was stalled several weeks in order to properly establish the equipment on-site. Furthermore, due to the late start-up date, much of the carbon monoxide monitoring

season was missed. Therefore, the data collected during this period is not representative of "worst case conditions" for carbon monoxide. The actual carbon monoxide monitoring season runs from November through March. It is during this period that the highest values for carbon monoxide are recorded in Massachusetts.

For the 1981 monitoring period, the one-hour maximum recorded value was 3.5 ppm; this value occurred on April 7, 1981, between the hours of 7:00 and 8:00 PM (see Appendix 18, Table 1, and Figures 1 and 2). The temperature during this period was 44.6°F with a southerly wind occurring at approximately 2 mph. The eight-hour maximum, 2.4 ppm occurred also on April 7 between the hours of 2:00 and 10:00 PM (see Appendix 18, Table 2, and Figure 3). The average temperature occurring during this period was 49°F with a predominant south-southwest wind occurring at an average speed of 4.0 mph. The eight-hour maximum is representative of a running/overlapping average, while the standard is based on a running/non-overlapping value. This tends to represent the "worst case" condition which we were striving for if the worst months had been monitored. There were no exceedances or violations of either the one- or the eight-hour NAAQS recorded for this period.

During the late 1981 and 1982 monitoring period, data capture totaled 182 days during the months of October, November, December, January, February, and March. Carbon monoxide data collected during this time period was representative of "worst case" conditions. The one-hour maximum recorded value 16 ppm, occurred on January 19, 1982, between the hours of 6:00 and 7:00 PM (see Appendix 18, Table 6 and Figure 7). The temperature at the time was 13°F with a southwesterly wind occurring at less than one mph. The eight-hour maximum recorded value 10.6 ppm occurred on December 5, 1981, between the hours of 6:00 PM to 1:00 PM December 6, 1981. The average temperature at that time was 10°F with a predominant southwest wind occurring at less than one mph. The 10.6 ppm recorded value is considered to be an exceedance of the standard and not a violation. There were no violations of the standard at the site for this period. There is an overlapping eight-hour value recorded on December 4, 1981 of 10.3 ppm but since this value overlapped with the December 5 data, it was discarded as a potential violation. However, it could be a reason for concern relative to the potential for a CO hot spot to develop in this area if there were to be any future development of the industrial park.

The original intent of this analysis, as stated in the work program, was to compare the CO levels recorded at the monitor before and after project implementation. This would enable the reviewer to assess the usefulness of those RACMs that had been implemented in terms of reducing automotive air pollution in the area. Due to problems in coordinating all

the necessary steps in order to obtain the necessary information to complete the above task, this was not accomplished. It was, therefore, not possible to perform the comparative analysis for a number of reasons; the monitoring periods were not the same representative months due to delays in start-up times, the traffic data was not collected at the same time period in some cases as the monitored data, and finally, extreme weather conditions which occurred during certain periods caused a loss of essential data capture. However, through the use of air quality models, it was possible to compare the estimated air quality impacts of the project.

3. NMHC AND CO LEVELS AS ESTIMATED BY MODELING PROCEDURES

a. Microscale Analysis: Carbon Monoxide (CO)

The microscale analysis estimates the ambient concentration of air pollutants that will be found within the project corridor at sensitive receptors identified within the area. The microscale analysis area encompasses the area adjacent to and within approximately 0.3 km of the monitoring equipment and roadways adjacent to this equipment. Given the nature of the motor vehicle-related pollutants and the state-of-the-art of predictive modeling, microscale analyses should be performed solely for carbon monoxide.

Microscale analysis necessitates the use of existing ambient air quality data and predictive models. In this case, the Caline-3 model, as adjusted for use in intersection analysis, was used.

b. Caline-3

Caline-3 is a third generation line source air quality model developed by the California Department of Transportation. It is based on the gaussian diffussion equation, and employs a mixing zone concept to characterize pollutant dispersion over the roadway.[1] The purpose of the model is to assess air quality impacts near transportation facilities in what is known as the microscale region. Given source strength (emission factors derived from Mobile 2B), meteorology, site geometry, and site characteristics, the model can reliably predict pollutant concentrations for receptors located within 150 meters of the roadway. At present, the model handles only inert pollutants, such as carbon monoxide or particulates. As a predictive tool, Caline-3 is well balanced in terms of the accuracy of state-of-the-art emissions and traffic models.[2]

---

[1]Benson, Paul. "Caline-3; A Versatile Dispersion Model for Predicting Air Pollutant Levels Near Highways and Arterial Streets," FHWA/CA/TL 79/23, November 1979.

[2]Ibid. Caline-3.

c. Mobile 2B

Mobile 2B computes emissions from highway motor vehicles utilizing the most recent emission factors, and calculating methodologies developed by the U. S. Environmental Protection Agency. It is made up of a series of integrated FORTRAN routines.

d. Results

The computer results for the 5:00 PM and 6:00 PM period, as run using Caline-3 and Mobile 2B, were 1.8 ppm and .1 ppm, respectively, minus the background values (see Tables 10 and 11). With a 3.0 ppm background value added in (a reasonable assumption given the vicinity of Route 128 to the project area), the values are 4.8 ppm and 3.1 ppm, respectively. These modeled values are within 1 ppm of the monitored values recorded on-site. The monitored values were 4.5 ppm and 2.5 ppm. The 3.0 ppm was used as suggested by DEQE in their technical memorandum entitled Background Values. The inputs used to run the model and the DEQE technical memorandum are included in Appendix 18, entitled Mobile 2B Emission Factor Runs.

e. Conclusions

There may be several reasons for the monitor/model discrepancy. One reason may have been the inability of Caline-3 to model wind speed less than 1 mph; the surface roughness variable (ZO) seems to be a relatively arbitrary choice within certain guidelines, and may impact the final results. In any case, one has to remember that all conclusions herein are based upon only two data points which occurred on March 9, 1981, at 5:00 PM and 6:00 PM. Therefore, the size of the sample severely limits the number of "absolute" conclusions one might draw from the project.

4. MESOSCALE ANALYSIS: NON-METHANE HYDROCARBONS (NMHC)

The mesoscale analysis estimates the contribution of emissions from a facility or series of facilities to the area-wide (regional) emissions from the existing road network. The analysis area includes an area anywhere from approximately 0.3 km to 16 km around and including the facilities to be analyzed. The exact geographical area depends on the local conditions and extent of a facilities impact on the travel patterns in the area. In all cases, the area should be large enough to include all roadway links that are directly or indirectly impacted by the project. In this case, the mesoscale analysis is used to estimate the total amount of non-methane hydrocarbons (NMHC) expected from the facilities within the Newton-Needham Industrial/Office Park for the before and after case.

```
WHAT NEXT? W = WIND DIRECTION, S = SEARCH FOR WORST WIND ANGLE,
           L = LINKS,          N = NEW CASE ENTIRELY,
           R = RECEPTOR,       X = EXECUTE THE PROGRAM,
          /* = END THE PROGRAM

>W
ENTER THE MINIMUM AND MAXIMUM WIND ANGLE & STEP SIZE
161 0 0
```

RECEPTOR 1

LINK	X1	Y1	X2	Y2	ANG	T	HT.	WIDTH	VPH	EF	CO
1	0.	0.	193.	0.	90.	1	.0	10.3	972.	117.0	.0
2	0.	0.	115.	-200.	150.	3	2.0	20.6	846.	168.0	1.8
3	12.	4.	26.	4.	90.	1	.0	13.3	2256.	100.0	.0
4	-4.	-4.	-24.	4.	292.	1	.0	13.3	2256.	100.0	.0
5	4.	-7.	24.	-41.	150.	3	2.0	13.3	2707.	100.0	.0
6	0.	0.	-100.	0.	270.	1	.0	10.3	903.	132.0	.0

WIND DIR	WIND SPD	STAB CLAS	MIX HT	SURF RUFF	DEP RATE	SETL RATE	AVE TIME	COORDINATES X	Y	Z	BKG	CO
161.	1.0	4(D)	183	175.	.0	.0	60.	89.	-113.	5.	.0	1.8

SOURCE : DEQE

5 pm modeled results
minus background

TABLE 10

5:00 PM CARBON MONOXIDE VALUES, NEWTON-NEEDHAM INDUSTRIAL/OFFICE PARK

```
WHAT NEXT? W = WIND DIRECTION, S = SEARCH FOR WORST WIND ANGLE,
           L = LINKS,           N = NEW CASE ENTIRELY,
           R = RECEPTOR,        X = EXECUTE THE PROGRAM,
          /* = END THE PROGRAM

>W
ENTER THE MINIMUM AND MAXIMUM WIND ANGLE & STEP SIZE
>141 0 0
```

RECEPTOR 1

LINK	X1	Y1	X2	Y2	ANG	T	HT.	WIDTH	VPH	EF	CO
1	0.	0.	193.	0.	90.	1	.0	10.3	568.	104.0	.0
2	0.	0.	-100.	0.	270.	1	.0	10.3	414.	122.0	.0
3	0.	0.	115.	-200.	150.	3	2.0	20.6	379.	164.0	.1
4	12.	4.	26.	4.	90.	1	.0	13.3	2256.	100.0	.0
5	-4.	-4.	-27.	4.	289.	1	.0	13.3	2256.	100.0	.0
6	4.	-7.	11.	-19.	150.	3	2.0	13.3	2707.	100.0	.0

WIND DIR	WIND SPD	STAB CLAS	MIX HT	SURF RUFF	DEP RATE	SETL RATE	AVE TIME	COORDINATES X	Y	Z	BKG	CO
141.	1.0	4(D)	103	175.	.0	.6	60.	89.	-113.	5.	.0	.1

6 PM modeled results
Minus background

SOURCE: DEQE

TABLE 11

6:00 PM CARBON MONOXIDE VALUES, NEWTON-NEEDHAM INDUSTRIAL/OFFICE PARK

Unlike the microscale analysis which deals with a localized area, the mesoscale analysis deals with a regional area (the New England Industrial Park in Figure 3) and pollutants in terms of total pollutant burden. In performing this analysis, it is not necessary to have specific meteorological data in order to reflect changes from year to year. The change in traffic allows for changes in overall pollutant burden over time.

The following data inputs were used in performing the mesoscale analysis:

<u>Traffic</u>

a. Identification of roadway lengths by link

b. Average daily traffic 1981, 1982 by link

c. Speeds by link

<u>Emission Factors</u>*

a. Vehicle age distribution

b. Percentage/cold, percentage/hot start

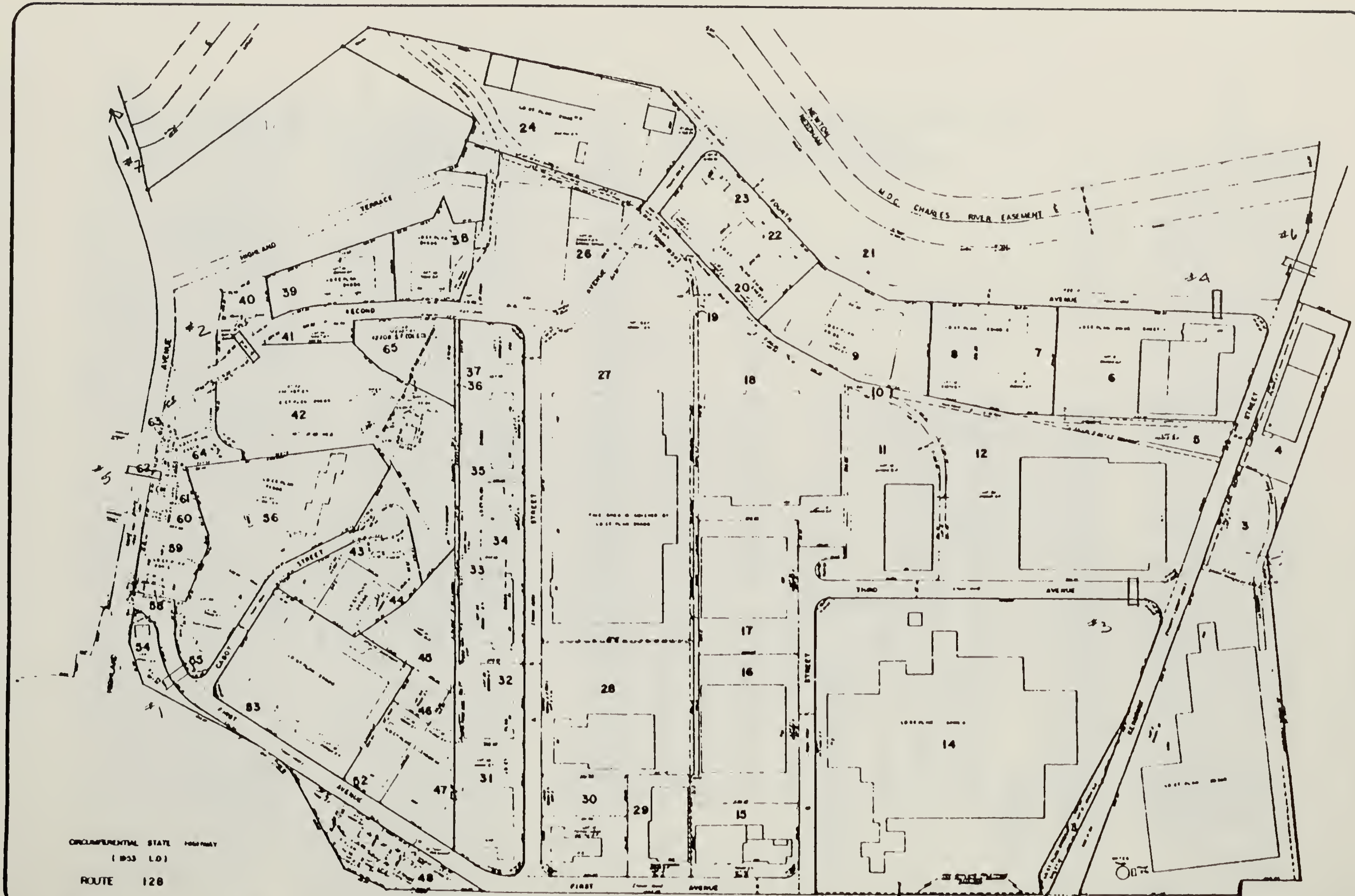
c. Vehicle mix

d. Temperature

*All emission factor inputs were the same as in the microscale analysis except the temperature was changed to 75^{o}F.

In performing the mesoscale analysis, 1981 and 1982 average daily traffic (ADT), supplied to DEQE by CTPS, was multiplied by the individual link lengths of all major roadway links in the mesoscale area (see Figure 19). The results were the derivation of total vehicle miles of travel for the entire mesoscale area. The total vehicle miles of travel data for each year was then multiplied by an emission factor derived from Mobile 2B for both 1981 and 1982. Total emissions for the mesoscale area were generated.

The emissions of NMHC generated per vehicle for 1981 were 7.08 grams per vehicle mile. For 1981, there were a total of 8,716 vehicle miles of travel generated in the project area which produced an NMHC pollutant burden of 61.7 kg/day. The emissions of NMHC generated per vehicle for 1982 were 5.58 grams/vehicle mile. For 1982, there were a total of 7,589 vehicle miles of travel generated in the project area which produced an NMHC pollutant burden of 42.3 kg/day. In comparing 1981 to 1982, this has resulted in a 19.4 kg/day or 31 percent reduction in total NMHC from 1981 to 1982 (see Table 12).



LIMITS OF MESOSCALE ANALYSIS

NEWTON-NEEDHAM RACM's STUDY

FIGURE 19

1981 AWDT

LINK:	TRAFFIC (AWDT)	X	AVERAGE DISTANCE	=	VMT
FIRST AVE.	6665	x	0.42	=	2799
SECOND AVE.	11,863	x	0.31	=	3678
THIRD AVE.	4,608	x	0.22	=	1014
FOURTH AVE.	5,833	x	0.21	=	1225
				Total VMT =	8716

8,716 VMT x 7.08 G of NMHC/mile = 61.7 Kg/Day

1982 AWDT

FIRST AVE.	6701	x	0.42	=	2814
SECOND AVE.	9000	x	0.31	=	2790
THIRD AVE.	3597	x	0.22	=	791
FOURTH AVE.	5686	x	0.21	=	1194
				Total VMT =	7589

7,589 VMT x 5.58 G of NMHC/mile = 42.3 Kg/Day [1]

1981 VMT = (8716) - (7589) 1982 VMT = 1127

[1] decrease of 31%

SOURCE: DEQE

TABLE 12

NON-METHANE HYDROCARBON ESTIMATES: 1981, 1982

The reductions of NMHC, which occurred from one year to another, may have been the result of the reasonably available control measures that were implemented over this time period. As noted in Table 12, VMT in the study area declined from 1981 to 1982. It can also be presumed that the naturally occurring reductions in emission factors, due to such ongoing programs as the Federal Motor Vehicle Emission Control Program, are contributors to these yearly reductions.

H. CONCLUSIONS AND RECOMMENDATIONS

1. TRAFFIC AND RIDESHARING

Whether or not ridesharing had a significant impact on local traffic largely depends on the data one examines. At the larger scale, ridesharing appears to have had only minor impact on local traffic. Examination of the AWDT data for all seven sites in the industrial area indicates that aggregate AWDT rose 4.2 percent between 1981 and 1982. While it is difficult to say what the value of aggregate AWDT might have been in the absence of the ridesharing program, at best the program's implementation slowed the growth of AWDT. It did not stop aggregate growth.

A partition of the aggregate traffic data makes this point more salient. If one separates traffic on local, surface streets from that on arterials, the differing impacts become apparent. AWDT on the arterials--Highland Avenue, Needham Street, and Kendrick Street-grew 7.5 percent between 1981 and 1982. By contrast, AWDT on streets within the New England Industrial Park declined 4.0 percent in this same period.

As noted in Section F.2, the MDPW ATR counts, the basis of the AWDT data, is known to overestimate actual traffic. Therefore, Table 13 was constructed. This table presents 1981 and 1982 manual counts for the PM peak period (3:30 - 5:30 PM) at the four access streets within the industrial park. These data indicate that PM peak period traffic declined 3.8 percent between March 1981 and March 1982. This decline corroborates the AWDT data.

While the traffic data indicate a decline in industrial park traffic following the ridesharing program's implementation, simple causality cannot be assumed between the two. The information presented in Section D.2.c indicated that several large employers in the area suffered employment layoffs during the 1981 - 1982 interval, while only one major employer increased its staffing level. Because of resource limitations, it was not possible to survey smaller firms in the industrial park. The manual count data suggests that these smaller firms are also likely to have experienced employee layoffs.

If one compares the 1981 and 1982 vehicle occupancy data--Tables 8 and 9--vehicle occupancy declined from 1.250 to 1.239 persons per vehicle, respectively. If employment in the industrial park had remained unchanged, then the observed decline in total traffic would imply a rise in vehicle occupancy. Since vehicle occupancy actually declined, then one is lead to infer that total employment also declined.

Location	1981 Turning Movement	1981 Classification	1981 Vehicle Occupancy	1982 Turning Movement	1982 Classification	1982 Vehicle Occupancy
First Avenue	757	841	768	729	755	811
Third Avenue	935	928	916	810	857	915
Fourth Avenue	936	1,173	1,086	949	1,082	1,085
Second Avenue NB	1,625	1,698	1,625	1,573	1,676	1,543
Second Avenue SB	368	412	412	332	375	442

Location	1981 Average	1982 Average	Difference	Percentage Change
First Avenue	789	765	- 24	- 3.0%
Third Avenue	926	861	- 65	- 7.0%
Fourth Avenue	1,065	1,039	- 26	- 2.4%
Second Avenue NB	1,649	1,597	- 52	- 3.5%
Second Avenue SB	397	383	- 14	- 3.5%
TOTAL	4,826	4,645	-181	- 3.8%

TABLE 13

NEWTON-NEEDHAM RACMS'S STUDY
COMPARISON OF 1981 AND 1982 PM PEAK-PERIOD TRAFFIC COUNTS

Finally, the vehicle occupancy figures were the most indicative measure of the program's effects. While the decline was small, the change obviously runs counter to expectation. This analysis must conclude that the ridesharing program did not convince area employees to share a ride to and from work.

2. AIR QUALITY AND RIDESHARING

As should be apparent from the preceding discussion, the impact of the ridesharing promotion on traffic was inconclusive. A variety of factors contributed to the apparent reduction in VMT within the study area, and no direct connection can be made between the formation of carpools and changes in traffic behavior. Because the level of pollutant emissions is a direct function of MVT, it cannot, therefore, be concluded that the apparent improvements to air quality in the study area were directly related to the ridesharing promotion.

Two different approaches were employed to establish the before and after effects of the program on air quality. Although extensive air quality monitoring of CO levels was performed, no useful comparisons could be made due to the incompatibility of the monitor data. To supplement the monitor data, a variety of air quality models were applied to the study area, the result being an indication of an apparent improvement in air quality with respect to NMHC. However, the VMT data inputs and emission factors employed in this calculation assure that some benefits will be shown despite the problematical quality of this traffic data. Even if no change in VMT were established, the reduction of NMHC emissions in grams per mile from 1981 to 1982, due to the impacts of the Federal Motor Vehicle Emission Control Program assure that some improvement will be shown. On the other hand, the data inputs which were used to calculate VMT are subject to sufficient random variation to warrant a conservative level of confidence with respect to their accuracy. As a result, no direct relationship can be reliably drawn between the impacts of ridesharing in the project area, traffic behavior, and air quality.

3. THE RIDESHARING EXPERIENCE

The Newton-Needham Commuter Program did not convince a significant number of employees from the industrial area to share a ride to work. In summary, the program did not work as planned. Why it did not work is the subject of this section. While much of the following discussion is conjecture, it is informed conjecture. It arises from constructing this experiment and is informed by the local Chamber of Commerce, managers from several firms operating in the study area, and professionals working in similar exercises elsewhere.

One of the principal factors working against a shift to ridesharing was the relatively generous supply of parking. For most businesses located in the study area, parking availability was not an issue. This is borne out by the employer survey. Of the 25 firms responding to the survey, only one identified the supply of parking as a problem. Given the supply of parking, employees can usually locate a parking space within short walking distance of their final destination. This situation provides little impetus for employees to complicate--even marginally--their commute to and from work.

If parking supply did not encourage a shift toward ridesharing, neither did other parking policies. At present, most parking is available on a first-come, first-served basis. As part of this program, employer's were urged to dedicate those spaces closest to their facility for employees ridesharing to work. No such change was made as a consequence of implementing this program.

Another disincentive to ridesharing was the distance separating most firms from local shopping and eating facilities. Without individual mobility, most employees were bound to their work place during the lunch period. Most employees were not willing to accept this limitation, according to managers working in the area.

The price and supply of gasoline also did little to spur a move toward ridesharing. During the 1981-1982 period, gasoline was in plentiful supply, and prices were relatively stable. These conditions eroded the economic incentive to rideshare, because by 1981, most commuters had adjusted their personal budgets to account for the increase in gasoline prices experienced in the 1970's.

Management's mixed support for the program appears to have affected its outcome. Those firms whose managers most aggressively promoted the program produced participation rates between 60 percent and 80 percent. However, participation rates below 20 percent were more usual. The data suggest that program participation--and quite probably program effectiveness--varied directly with management's support for ridesharing.

Previous experience with ridesharing may have already saturated the local market available for ridesharing. Of the firms responding to the survey, 45 percent of them had had experience with ridesharing. Also, of the nine firms surveyed with more than 100 employees, seven had already promoted ridesharing. As noted earlier, the MDPW promoted a multi-employer ridesharing program in the area in 1979. All these observations point to a significant experience with ridesharing. Assuming these programs already precipitated some employees to rideshare, there may have been limited potential to affect an additional shift toward ridesharing.

The economic recession of 1981-1982 may have hindered the formation of a significant number of carpools. As noted earlier, there were significant staff cutbacks within several firms operating in the study area. It is the opinion of managers working in the area that the recession caused employees to feel anxious about their job security. Under these conditions, employees were understandably reluctant to experiement with their personal transportation mode.

Finally, the fact that management initiated and promoted the ridesharing program may have worked against the program's success. It was suggested--again, by people working in affected business--that some employees mistrust most initiatives taken by management. Thus, the decision to initiate this program from the top (management) and work down (individual employees) may have hampered its effectiveness.

In summary, the ridesharing program required both strong incentives and disincentives to produce an effective outcome. In this case, neither the incentives nor the disincentives were compelling enough to produce a significant shift toward ridesharing.

There were almost no extraordinary costs associated with commuting alone to work. The high out-of-pocket costs had been accommodated by most drivers well before this ridesharing program's inception. Once at the work place, most drivers found plentiful parking within a short walk of their final destination. Stability in gasoline supply and price only contributed inertia in maintaining the status quo.

Confronted with these conditions, only the most extreme incentives could have contributed to the program's success. It is doubtful that preferential parking, i.e., providing dedicated parking spaces next to a facility entrance, for ride-sharers would have had a significant effect on the decision to rideshare. The benefit of preferential parking would have been compensated with more time at the trip's home end. A strategy like an employer's contribution to out-of-pocket costs might have promoted a shift toward greater ridesharing. But, this and related strategies remain the subject of other studies.

4. RECOMMENDATIONS

Before presenting recommendations regarding future ride-sharing programs, it seems appropriate to sketch the context in which the recommendations are made. The goal of this--and presumably of future ridesharing program(s)--is to facilitate the formation of new or expanded carpools for the work trip. It is naive to believe that the mere act of generating matching

lists will foment these carpools. The decision to form or join a carpool is usually a decision to change an established and rationalized, if not always rational, pattern of behavior. As such, the ridesharing decision has costs associated with it. It is the opinion of these analysts that a ridesharing promotion can be successful only if these costs are understood.

The commute to and from work involves at least two types of costs: out-of-pocket costs and other perceived costs. Most individuals choose a commuting mode so as to minimize his or her total costs. The focus of most ridesharing promotion is on out-of-pocket costs, i.e., gasoline costs. This was the case with this effort. But, the limited response to this and other similar efforts should indicate that commuters are not strongly responsive to changes in out-of-pocket costs. Consequently, it seems logical to focus on other perceived costs.

These other perceived costs associated with ridesharing include increased in-vehicle time, due to route circuity and waiting time. The fact that many commuters who could rideshare do not, argues that the benefits to be gained by ridesharing do not compensate for the costs incurred in doing so. Extending this argument, one is lead to ask is it likely that a lone commuter might decide to rideshare? A change in commuting behavior would be regional when the costs of driving alone are high and when the perceived benefits derived from ridesharing can be made at least as high as the associated costs. The lone commuter must perceive that he or she will be generally better off by ridesharing than by driving alone to precipitate a change in his or her commuting behavior.

These general comments lead to more specific ones. In fact, they lead to specific recommendations. These recommendations are directed toward ridesharing programs in suburban settings.

1. Site Selection.--To be successful, ridesharing should be promoted at locations where the supply of parking is short relative to demand. The greater the competition for available parking, the better is the likelihood that the ridesharing promotion might precipitate carpool formation. There are suburban office parks in the Boston metropolitan area where the use of remote parking lots is necessary, and employees are shuttled to their destination. In these circumstances, employers are under pressure to construct new parking facilities. Employers should be encouraged to explore other options, like ridesharing, as an alternative strategy to addressing their parking problems.

2. Incentives.--Preferential parking and employer subsidies can be effective ridesharing incentives, but this presupposes that parking availability is a problem. Where parking

lots are large, walking distances are long, and competition for space is strong, preferential parking might produce significant enough a benefit on the work end of the commute to justify greater cost at the home end. This is especially true where remote parking lots are in use.

When employers are faced with the cost of expanding their parking supply, they should be made aware that ridesharing is a relatively low-cost, short-range strategy for addressing the problem. Rather than building new parking capacity, employers' direct costs might be reduced by subsidizing their employees who join carpools or vanpools. At a minimum, ridesharing should be promoted as an interim, mitigating measure.

To sum up, in a suburban setting, the applicability of ridesharing as an effective Reasonably Available Control Measure (RACM) to improve air quality is likely to be more limited than applicability in an urban setting. Whereas, commuting to an urban-based work place is usually characterized by limited and expensive parking, moderate walking distance between work place and parking, and individual responsibility for parking, commuting to a suburban-based work place is not so characterized. In the latter, the supply of parking is usually generous and free (at least for the user), walking distances tend to be short, and responsibility for the parking supply is the employers.

These suburban characteristics imply that the prevalent commuting mode will be the single-occupant vehicle. A significant shift from this mode to ridesharing is not likely to be made unless the parking supply is exhausted. However, as the demand for parking approaches the limits of supply, the employer can exercise a significant influence in commuting mode. Since by practice and, hence, expectation, the suburban employer is responsible for parking supply, he or she can influence modal choice to a degree not usually experienced by urban employers.

APPENDICES

1. Initial Project Mailing List
2. Newton-Needham Commuter Program: Employer Survey Form
3. Newton-Needham Commuter Program: Employer Meeting Agenda and Minutes (September 15, 1981)
4. Newton-Needham Commuter Program: Employee Survey Form
5. Letter to Transportation Coordinators (September 21, 1981)
6. Newton-Needham Business newsletter article on project
7. Sample Press Release
8. Publicity Poster (reduced size)
9. Meeting Minutes (December 17, 1981)
10. Letter to Transportation Coordinators (December 17, 1981)
11. Meeting Minutes (January 19, 1982)
12. Letter to Transportation Coordinators (February 11, 1982)
13. Newton-Needham Transportation Project: Employer Survey Form
14. Newton-Needham Commuter Program: Employer Survey Results
15. Comparison of 1981 and 1982 Traffic Data
16. Capacity-Analysis Worksheets: 1981 Actual (16-1, 16-2); 1982 Actual (16-3, 16-4); Hypothetical Change in Cycle Length and Green-time Allocation (16-5)
17. Vehicle Classification
18. Air-Quality Data

APPENDIX 1

INITIAL PROJECT MAILING LIST

Jason Starr
Boston Showcase
66 Winchester Street
Newton Highland, MA 02161

Jack Freedman
Boston Desk Company
71 Needham Street
Newton Highlands, MA 02161

Ronald Erbetta
Balco, Inc.
160 Charlemont Street
Newton Highlands, MA 02161

William Newell, Mgr.
Automatic Sprinkler Corp.
53 Winchester Street
Newton Highlands, MA 02161

Kenneth M. Bleakney, Mgr.Emp.Rel.
F.E.D. - Home Office
Honeywell, Inc.
141 Needham Street
Newton Highlands, MA 02161

Murray Rudnick, Pres.
Fox Travel
100 Winchester Street
Newton Highlands, MA 02161

Edward R. Thaler
E.R.T. Enterprises, Inc.
55 Needham Street
Newton Highlands, MA 02161

George C. Riley
Community Services Station, Inc.
79 Needham Street
Newton Highlands, MA 02161

John Shemligion
Itek Corporation
27 Christina Street
Newton Highlands, MA 02161

Shirley Henderson
Personnel Administrator
Itek Corporation
27 Christina Street
Newton Highlands, MA 02161

Stanley N. Golembe
Itek Corporation
27 Christina Street
Newton Highlands, MA 02161

Sy Kraut, V.P. Gen. Mgr.
Honeywell, Inc. F.E.D.
151 Needham Street
Newton Highlands, MA 02161

Vicki Tomasz
Personnel Dept.
LTX Corporation
160 Charlemont Street
Newton Highlands, MA 02161

Richard Tennant, Controller
LTX Corporation
160 Charlemont Street
Newton Highlands, MA 02161

Richard Boltrus
V.P. Operations
LTX Corporation
160 Charlemont Street
Newton Highlands, MA 02161

Robert M. Imrie
Harlow Imrie Corp.
49 Needham Street
Newton Highlands, MA 02161

Frank H. Bonanni
Minuteman Press
86 Winchester Street
Newton Highlands, MA 02161

Roy Blondell
H.M. Nordstrom Co.
12 Dedham Street
Newton Highlands, MA 02161

Louis Kaitz
National Lumber Co.
15 Needham Street
Newton Highlands, MA 02161

Doug Stuart, Pres.
Lee Loumos, Inc.
78 Winchester Street
Newton Highlands, MA 02161

Kenneth Wexler
Wexler Construction Co., Inc.
118 Needham Street
Newton Highlands, MA 02161

Peter Terrazzino
Transmissions, Inc.
106 Needham Street
Newton Highlands, MA 02161

Lucille G. Cline
Payne Associates, Inc.
51 Winchester Street
Newton Highlands, MA 02161

Peter Murphy
P & C Company
17 Kenneth Street
Newton Highlands, MA 02161

Peter J. White
Boston Fish House
227 Needham Street
Newton Upper Falls, MA 02164

Victor A. Nicolazzo
Bigelow Oil Co.
50 Tower Road
Newton Upper Falls, MA 02164

Jack Morrissey
BoJack Beauty & School
242 Needham Street
Newton Upper Falls, MA 02164

Damon Corporation
115 Fourth Avenue
Needham Heights, MA 02194

Ferrone Associates
255 Highland Avenue
Needham Heights, MA 02194

Fashion World, Inc.
10 Charles Street
Needham Heights, MA 02194

William K. Nunno
Elliot Oil & Service Co., Inc.
78 Freemont Street
Needham Heights, MA 02194

Driscoll-Pearce, Inc.
687 Highland Avenue
Needham Heights, MA 02194

Richard Fidler, V.P. & Gen. Mgr
GTE Products Corp., S.S.D.
189 B Street
Needham Heights, MA 02194

Ernest Chadwick
GTE Sylvania Systems
77 A Street
Needham Heights, MA 02194

Nathaniel C. Fowler
Fowler Printing Co.
50 Brook Road
Needham Heights, MA 02194

Robert Fields
Fields Hosiery
206 A Street
Needham Heights, MA 02194

Frank Gicca, V.P. & Gen. Mgr.
GTE Sylvania Systems
Communication System Div.
77 A Street
Needham Heights, MA 02194

Frederick W. Giggey
Mgr. Business Dev. Org.
GTE Products Corp., S.S.D.
189 B Street
Needham Heights, MA 02194

R.F. Gamble
GTE Products Corp., S.S.D.
189 B Street
Needham Heights, MA 02194

John Fox
GTE Sylvania Systems
Communications Systems Div.
77 A Street
Needham Heights, MA 02194

Thomas A. Tierney
Mgr. Industrial Relations
GTE Products Corp.,
189 B Street
Needham Heights, MA 02194

S.H. Szen
GTE Products Corp., S.S.D.
189 B Street
Needham Heights, MA 02194

[illegible]J. LaFave
GTE Products Corp., S.S.D.
189 B Street
Needham Heights, MA 02194

Richard Hawes
GTE Products Corp., S.S.D.
189 B Street
Needham Heights, MA 02194

John T. Clark
Genalco, Inc.
322 Reservoir Road
Needham Heights, MA 02194

[illegible].F. Warren, Jr., Controller
GTE Sylvania Systems
Communication Systems Division
77 A Street
Needham Heights, MA 02194

J.T. Turner
Mgr. Industrial Relations
GTE Sylvania Systems, C.S.D.
77 A Street
Needham Heights, MA 02194

Robert L. Triveri
Supervisor; Facilities
GTE Sylvania Systems, C.S.D.
77 A Street
Needham Heights, MA 02194

Robert Bolster
Howard Johnson's Restaurant
8 First Avenue
Needham Heights, MA 02194

Rand Engel
Home Energy Centers, Inc.
49 Highland Avenue
Needham Heights, MA 02194

Harry Halliday
Halliday Hospital Supply, Inc.
61 Fourth Avenue
Needham Heights, MA 02194

Larry Crane, Mgr.
Gestetner Corp.
50 Cabot Street
Needham Heights, MA 02194

Paul R. McLaughlin
Intern'l House of Pancakes
669 Highland Avenue
Needham Heights, MA 02194

Roy L. Larsen
Impact Sales Co., Inc.
200 First Avenue
Needham Heights, MA 02194

Helen Sundhauss
Imlac Corporation
150 A Street
Needham Heights, MA 02194

Bruce Backe
Imlac Corporation
150 A Street
Needham Heights, MA 02194

Richard J. Stewart, Pres.
Charles P. Lauman Co., Inc.
337 Reservoir Street
Needham Heights, MA 02194

BayBank Middlesex
242 Needham Street
Newton Upper Falls, MA 02164

Contract Sales, Inc.
180 Needham Street
Newton Upper Falls, MA 02164

Champagne Offset Co., Inc.
210 Needham Street
Newton Upper Falls, MA 02164

Ted Laridis
Boy on a Dolphin Restaurant
103 Oak Street
Newton Upper Falls, MA 02164

Stanley L. Grier
Ava Botelle Fashions
201 Needham Street
Newton Upper Falls, MA 02164

Catherine Mennilli, Mgr.
Freedom Federal Savings
241 Needham Street
Newton Upper Falls, MA 02164

James H. McManus, Jr.
Fox & Hounds Properties
244 Needham Street
Newton Upper Falls, MA 02164

Nathan Berkowitz
Fox & Hounds Properties
244 Needham Street
Newton Upper Falls, MA 02164

Douglas L. Turcotte
Douglas Realty
285 Needham Street
Newton Upper Falls, MA 02164

Peter Lillios, Pres.
Intern'l Totalizer Systems
1254 Chestnut Street
Newton Upper Falls, MA 02164

Donald B. Hilton, CPA
Hilton, Walker & Vecchi
381 Elliot Street
Newton Upper Falls, MA 02164

Robert Hill
General Electric Co.-Lamp Div.
50 Industrial Place
Newton Upper Falls, MA 02164

Mirick Friend
Friend Management Corp.
381 Elliot Street
Newton Upper Falls, MA 02164

Frank Mann, Pres.
Mann Data, Inc.
50 Tower Road
Newton Upper Falls, MA 02164

Alan C. Baker
Malba, Inc.
28 Richardson Road
Newton Upper Falls, MA 02164

Gerald Leehan
Justin's Restaurant
244 Needham Street
Newton Upper Falls, MA 02164

Edward Schroter
Intern'l Totalizer Systems
1254 Chestnut Street
Newton Upper Falls, MA 02164

Larry Wolozin
Mill Falls Restaurant
383 Elliot Street
Newton Upper Falls, MA 02164

Robert R. Morelli
Nick Mack Railroad
Builders Corporation
385 Elliot Street
Newton Upper Falls, MA 02164

Richard N. Coy
Marshalls of Newton, Inc.
245 Needham Street
Newton Upper Falls, MA 02164

John Bois
Marshalls of Newton, Inc.
245 Needham Street
Newton Upper Falls, MA 02164

Joseph Barrett, Mgr.
Newport Creamery, Inc.
241 Needham Street
Newton Upper Falls MA 02164

David L. Nocella, Exec. V.P.
NRC, Inc.
45 Industrial Place
Newton Upper Falls, MA 02164

John B. Frederickson, Mgr.
NRC, Inc.
45 Industrial Place
Newton Upper Falls, MA 02164

Lawrence A. Collins
NRC, Inc.
45 Industrial Place
Newton Upper Falls, MA 02164

Anthony C. Casale, Gen. Mgr.
WN Ormsby Roofing & Const. Co.
1185 Chestnut Street
Newton Upper Falls, MA 02164

Charles Nigohsian
John M. Nigohsian & Son, Inc.
210 Needham Street
Newton Upper Falls, MA 02164

Naomi Cauger
Newton Professionals, Inc.
50 Tower Park Road
Newton Upper Falls, MA 02164

Adrian Colasacco, Pres.
Newton Electrical Company
44 Mechanic Street
Newton Upper Falls, MA 02164

Paul Fortin, Resident Mgr.
St. Regis Laminated & Coated
Products Division
156 Oak Street
Newton Upper Falls, MA 02164

St. Regis Laminated & Coated
Products Division
156 Oak Street
Newton Upper Falls, MA 02164

S.E.M. Company, Inc.
233 Needham Street
Newton Upper Falls, MA 02164

Printcentre
233 Needham Street
Newton Upper Falls, MA 02164

Eugene S. Tarsky, CPA
381 Elliot Street
Newton Upper Falls, MA 02164

Phyllis Wlotzko
Travel Your Way, Inc.
281 Needham Street
Newton Upper Falls, MA 02164

Jody Doherty, Mgr.
Stacy's-Fashion World
Marshall's Shopping Mall
241 Needham Street
Newton Upper Falls, MA 02164

Charles Miklosovich, Pers. Mgr.
St. Regis Laminated & Coated
Products Division
156 Oak Street
Newton Upper Falls, MA 02164

Charles M. Roberts
VWR Scientific, Inc.
260 Needham Street
Newton Upper Falls, MA 02164

John Recco
Upper Falls Beverage Store, Inc
150 Needham Street
Newton Upper Falls, MA 02164

Henri M. Weil, Plant Mgr.
Tenneco Chemicals, Inc.
300 Needham Street
Newton Upper Falls, MA 02164

Gini Bowen, Personnel Mrg.
Tenneco, Inc.
300 Needham Street
Newton Upper Falls, MA 02164

Philip Cacciatore
American Door Distributors
15 Fourth Avenue
Needham Heights, MA 02194

Andrew Petkun
Allen Furniture
250 First Avenue
Needham Heights, MA 02194

Dennis Must
Algonquin, Inc.
19 Brook Road
Needham Heights, MA 02194

Robert T. Edgar
Albany International
110 A Street
Needham Heights, MA 02194

Peter Bruen
Bruen Incorporated
45 Fourth Avenue
Needham Heights, MA 02194

Glenn Stewart, Pres.
Boston Saw & Knife
292 Reservoir Street
Needham Heights, MA 02194

Walter M. Mulock, Asst. Treas.
BayBank Norfolk County Trust Co.
40 First Avenue
Needham Heights, MA 02194

Anthony Berejik
Berejik Motors
126 Highland Avenue
Needham Heights, MA 02194

Charlotte J. Kaye, Supervisor
Employee Benefits
Damon Corporation
115 Fourth Street
Needham Heights, MA 02194

Timothy X. Cronin
Cronin Electronics, Inc.
77 4th Avenue
Needham Heights, MA 02194

William P. Casey, Pres.
Coca Cola Bottling Co. of N.E.
9 B Street
Needham Heights, MA 02194

John E. Casey
Casey Petroleum Products
30 Charles Street
Needham Heights, MA 02194

Robert Rivers
Damon Corporation
115 Fourth Avenue
Needham Heights, MA 02194

D. Joseph Powell
Damon Corporation
115 Fourth Avenue
Needham Heights, MA 02194

Gary H. Mansur, Director of
Corporate Communications
Damon Corporation
115 Fourth Avenue
Needham Heights, MA 02194

Bruce R. Scally
Kraft Foods
37 A Street
Needham Heights, MA 02194

Michael A. Valerio
Papa Gino's of America, Inc.
111 Cabot Street
Needham Heights, MA 02194

Blaine O'Dell, Jr., Branch Mgr.
Merck Sharp & Dohme
40 A Street
Needham Heights, MA 02194

Howard Corey, Mgr.
Inventory Operations--Distrib.
Polaroid Corporation
140 Kendrick Street
Needham Heights, MA 02194

Robert L. Langlois
Ritta Personnel
109 Highland Avenue
Needham Heights, MA 02194

Max. H. Bickelman
Superior Vinyl of N.E., Inc.
109 Highland Avenue
Needham Heights, MA 02194

James P. Petrakos, Pres.
The Silver Gallery, Inc.
238 Highland Avenue
Needham Heights, MA 02194

Gerald I. Hermanson, Pres.
Technical Papers Corp.
29 Franklin Street
Needham Heights, MA 02194

William B. Valencia
Valco Company, Inc.
55 Franklin Street
Needham Heights, MA 02194

Irvin G. Petkun
Kentco Corp.
65 Fourth Avenue
Needham Heights, MA 02194

Harry Heesch, Dir. of Public
Affairs
Papa Gino's of America, Inc.
111 Cabot Street
Needham Heights, MA 02194

Nick Johnson
Polaroid Corp.
Distribution Center
140 Kendrick Street
Needham Heights, MA 02194

Robert Nutting, General Mgr.
Park Tower Motor Inn, Inc.
100 Cabot Street
Needham Heights, MA 02194

Karl Whelan
Corporate Transportation Mgr.
Polaroid Corp.
151 Third Avenue
Needham Heights, MA 02194

James E. Carroll
Standard Walls, Inc.
39 Highland Circle
Needham Heights, MA 02194

W.J. Bussow
The 3 M Company
155 Fourth Avenue
Needham Heights, MA 02194

Clinton E. Roche, Mgr.
Seafarer/ELF Operations
Sylvania Systems, C.S.D.
189 B Street
Needham Heights, MA 02194

Gary March
The Upjohn Company
410 First Avenue
Needham Heights, MA 02194

Joseph Cunning
J M Construction Corp.
163 Reservoir Street
Needham Heights, MA 02194

Jerome Lynch
Needham Body Shop, Inc.
69 Franklin Street
Needham Heights, MA 02194

James E. Grinell
General Manager of Distrib.
Polaroid Corporation
140 Kendrick Street
Needham Heights, MA 02194

Robert A. Prescott
Scott Electrical Supply Co.
56 Brook Road
Needham Heights, MA 02194

Nathaniel Cohen
Redd's Deli, Inc.
250 Highland Avenue
Needham Heights, MA 02194

Earl Lieberman, Pres.
Sleepers Showcase
238 Highland Avenue
Needham Heights, MA 02194

Walter T. Arnhols
Branch Operations Mgr.
The 3 M Company
155 Fourth Avenue
Needham Heights, MA 02194

William B. Knight
WXNE-TV
100 Second Avenue
Needham Heights, MA 02194

Ms. Carol D. Moore, Mgr.
Union Carbide Corporation
300 First Avenue
Needham Heights, MA 02194

APPENDIX 2

NEWTON-NEEDHAM COMMUTER PROGRAM

EMPLOYER'S SURVEY

Please complete all applicable questions and return this form to the Metropolitan Area Planning Council in the enclosed postage-paid envelope. Your answers will assist in efforts to improve transportation to the Newton-Needham area. If you have any questions concerning this survey, please call either Denny Lawton (MAPC) at 451-2770 or Bob Reyes (Central Transportation Planning Staff) at 451-5785.

Date: ______________________

1) Name of Firm: ______________________

Address: ______________________

____

____

Briefly describe the nature of your business:

____

____

____

2) Name of person completing this form: ______________________

Title: ______________________

Phone #: ______________________

3) Total Number of Employees at your Newton-Needham location: __________

Number of Employees by category:

Office/Clerical: __________

Manufacturing: __________

Other (please describe): ______________________

____

____

4) Hours of Work Shifts: ______________________

____

5) Using the information from Questions 3 and 4, please complete the following table:

Number of Employees:

Hours of Shifts	Office/Clerical	Manufacturing	Other

6) Does your firm utilize flexible work hours, a shortened work week or sliding shifts?

Please circle: Yes No

If no, go to Question 7.

If yes, please describe: ______________________________

____

____

____

____

Which employees are eligible to participate? ______________________________

____

____

How well is it working? ______________________________

____

____

If you answered no to the above, would your firm be willing to consider some form of flexible work hours if it would encourage ridesharing?

Please circle: Yes No

7) How many employee parking spaces are available: ______________________

(Include a sketch of lot layout if possible)

Are there any particular problems regarding parking availability?

____

____

____

Does your firm have special parking policies (i.e. Executive Parking Only area, carpooling area, etc.)? Please describe: ______________________

____

____

____

8) Has your firm ever promoted employee participation in ridesharing programs?

Please circle: Yes No

If yes, please describe the program and evaluate its level of success:

____

____

____

9) Would you or your staff be available to assist in the promotion of a ridesharing program?

Please circle Yes No

If so, who should be contacted in the future as Transportation Coordinator?

Name: ____________________ Title: _____________ Phone #: __________

10) Does your company publish a newsletter that could be used to publicize ridesharing programs?

Please circle Yes No

NOTE: Please return this survey by October 2, 1981. Thank you!

THANK YOU FOR YOUR TIME AND ASSISTANCE!

APPENDIX 3

NEWTON-NEEDHAM COMMUTER PROGRAM
EMPLOYER MEETING: SEPTEMBER 15, 1981
AGENDA

I.	Introduction	Lewis Songer, Newton-Needham Chamber of Commerce
II.	Purpose of Program	Bob Reyes, Central Transportation Planning Staff
III.	Advantages of Ridesharing	Jennifer Parker, Executive Office of Transportation & Construction Jeanne Amato, CARAVAN
IV.	How the Program Works	Denny Lawton, Metropolitan Area Planning Council
V.	Comments and Questions	
VI.	Appointment of Steering Committee	

CTPS

central transportation planning staff
27 school street boston massachusetts 02108 (617) 451-5785

MEMORANDUM

TO: Archives September 15, 1981

FROM: Bob Reyes

RE: Organizational Meeting for the Newton-Needham RACM's Project

The meeting was held at GTE Sylvania, 77 "A" Street, Needham, Massachusetts, from 11:00 to 12:00 PM.

John Fox of GTE Sylvania hosted the meeting. The following people also attended:

Gertrude Gately - GTE Sylvania
Paul Fortin - St. Regis
Will Hood - Coca Cola
Stan Golembe - Itek
Ray Godbout - Tenneco
Lew Songer - Newton-Needham Chamber of Commerce
Jennifer Parker - EOTC
Jean Amato - Caravan
Denny Lawton - MAPC
Bob Reyes - CTPS

Lew Songer of the Chamber of Commerce made a few introductory remarks. He gave a brief history of efforts to address the traffic congestion on Highland Avenue/Needham Street. Specifically, Lew mentioned an oral commitment from former commissioner of the Massachusetts Department of Public Works (MDPW), Dean Amidon, to promote Highland Avenue/Needham Street for an Urban Systems study. Since Mr. Amidon had resigned as commissioner, Lew questioned if the new commissioner would feel bound to his predecessor's promise. The current fiscal environment, Lew argued, did not bode well for a quick engineering solution to the congestion problem.

Lew stressed that aggressive promotion of the ridesharing program was one strategy which the local business community could take to help alleviate the congestion problem. In light of the remoteness of other kinds of immediate solutions,

Lew pressed his colleagues to "adjust the attitude" of business managers, who were reluctant to participate in the ridesharing program.

Following Lew's remarks, presentations were made to explain and promote the program by Bob Reyes, Jennifer Parker, Jean Amato, and Denny Lawton. Bob's presentation focused on the program's background and goals. Jennifer explained the advantages to employers and employees from participating in the carpooling program. Jean explained the differences between carpooling and vanpooling; she also presented the distinct advantages of vanpooling and the "nuts and bolts" of the vanpooling operation. Denny then explained the operation of the carpooling program.

Following the presentations, questions were taken from the group. One issue, which several people raised, was the tenuousness of finding people within small- to medium-sized firms who would share the commute to work. The expression of this concern underscored the importance of making the program a multi-employer ridesharing program. This point was repeated several times by the agency-related participants.

The meeting ended after a brief discussion concerning a follow-up meeting on October 5. A draft invitation was circulated, and it was agreed that comments on the draft would be given to Bob Reyes by Friday, September 18. The invitation to most employers in the area is to be mailed out by Monday, September 21.

BR:sb

APPENDIX 4

Newton-Needham Commuter Program

This form will be used to identify potential carpoolers and vanpoolers among employees in the Newton-Needham Industrial area. You may then choose whether to pool and with whom. The few minutes you spend to complete this questionnaire may save you hundreds of dollars each year. Whether or not you wish to ride-share, please complete this card.

Please Print all information, one letter in each block.

Action Code [1][A] (1–2)

Commuter ID Number [ ][ ][5][1][3] (7–11)

First Name (12–21)

Last Name (23–35)

Home Street Address or if you prefer, identify your section of the city. (36–56)

[ ] (58) **If you do not want your address printed on carpool lists, check here.**

City or Town (59–73)

State (74)

Zip (76–80)

Action Code [2][A] (1–2)

Please leave these boxes blank. (7–11)

Home Grid Square Number
X: (12) Y: (14)

Consult instructions on the Masspool maps to find the X and Y numbers of the box around your residence.

What time do you usually arrive for work? Hr Min (20–22) [ ] AM [ ] PM (24)

Example: show 6:30 A.M. as Hr Min [0][6][3][0] [✓] AM [ ] PM

What time do you usually leave from work? Hr Min (25–27) [ ] AM [ ] PM (29)

Example: show 2:30 P.M. as Hr Min [0][2][3][0] [ ] AM [✓] PM

Ridesharing Interest
[ ] (30) Please see enclosed materials and fill in numbers.

1 = carpooling
2 = vanpooling
3 = both
4 = I am not interested

Telephone at Home or Work (31–33) — (34, 35–38) Ext. (40–44)

Ridesharing Preference
[ ] (47) Fill in number

1 = I prefer to ride or drive
2 = I prefer to ride only
3 = I prefer to drive only

Current Commuting Method
[ ] (50) Fill in number

1 = I drive to work alone
2 = I carpool with others
3 = I vanpool with others
4 = I take public transportation
5 = I walk
6 = I bicycle, taxi, other

Company Name (53–67)

Work Location (68–72)

See instructions for your location code.

pool

NO POSTAGE
STAMP
NECESSARY
IF MAILED
IN THE
UNITED STATES

BUSINESS REPLY MAIL

FIRST CLASS PERMIT NO. 44298 BOSTON, MASS

Postage will be paid by addressee

Metropolitan Area Planning Council
110 Tremont Street
Boston, Massachusetts 02108

APPENDIX 5

mapc Metropolitan Area Planning Council 110 Tremont St., Boston, MA 02108 617/451-2770

September 21, 1981

In addition to the ongoing efforts for finding an engineering solution by the state, there is an immediate opportunity for your firm to do something now to help the traffic problem that occurs on Highland Avenue/Needham Street every weekday morning and afternoon. The business community in the area is in the process of trying to alleviate the problem, and we hope that you will join in our effort.

Area firms, working with the Newton-Needham Chamber of Commerce, and in cooperation with the Metropolitan Area Planning Council (MAPC), are organizing a ridesharing program. The object of this program is to enlist as many of the area's employees as possible into sharing a ride to and from work. By getting people to carpool or vanpool, we can lower the number of cars in the area during the peak commuting periods, when the congestion problem is at its worst.

We are arranging an organizational meeting for October 5, 3:00 p.m. at GTE Sylvania, 360 First Avenue in Needham Heights. We are asking you to appoint a ridesharing coordinator to represent your company at this meeting. Your coordinator will meet with the ridesharing coordinators from businesses on and adjacent to Highland Avenue/Needham Street. We would like your co-ordinator to be responsible for distributing commuter survey cards, instructing your employees on how to correctly complete the survey cards, retrieving the cards, and distributing ridesharing matching lists to interested employees. This should require only a few hours of his or her time in a small company, more in a large company.

Responsibilities for the ridesharing program are being shared by two of the region's urban planning agencies. MAPC and the Central Transportation Planning Staff (CTPS) are assuming responsibility for overall program organization, information processing, and computer operations. MAPC and CTPS will also perform additional duties necessary to ensure successful program implementation.

Enclosed you will find a copy of an employer survey form. Please complete the form and mail it back in the envelope provided. The information obtained from this survey will help the project organizers to better understand the transportation problems and needs of the Newton-Needham area.

Please complete this form even if you do not intent to participate in the ridesharing effort. This information will help the region's transportation planning agencies to address the specific transportation needs of this community.

For this minor investment, we think that you will save yourself and your employees time and aggravation. If you help make this program successful, you will also help in reducing everyone's commuting time and costs. While all of us would like to see street improvements on Highland Avenue/Needham Street, the prospect is that, given current funding considerations, these improvements will not occur in the near future. What all of us can do immediately is work to relieve some of the congestion by getting some of the cars off of these streets now. Please call the Chamber at 244-5300 with the name of your representative by October 2nd.

Sincerely,

Denny Lawton
Transportation Planner, MAPC

Bob Reyes
Principal Planner, CTPS

Lewis B. Songer
Executive Vice President
Newton-Needham Chamber of Commerce

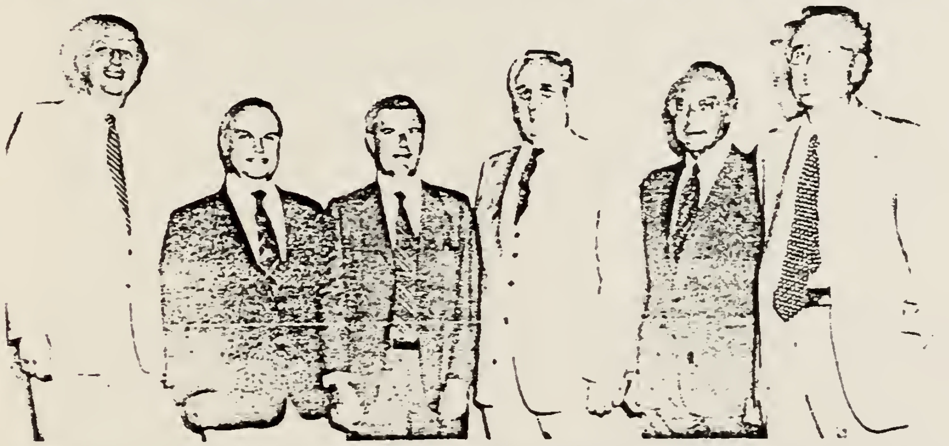
Enclosure

APPENDIX 6

NEWTON-NEEDHAM BUSINESS

VOLUME XXIII, NUMBER 9 TEL. (617) 244-5300 NEWTON-NEEDHAM, MASSACHUSETTS SEPTEMBER-OCTOBER, 1981

CTPS, CHAMBER LAUNCH RIDE-SHARING PLAN



Attorneys at the Chamber's first Lawyers' Council dinner meeting at Holiday Inn are shown, *left to right:* Attys. David Mofenson, Edward Richmond and Don Budge (Chairman *pro tem*); Newton District Court Judge Monte Basbas; Probate Judge Eliot Cohen and Atty. Rodney Barker.

An idea whose time has come is that of ride-sharing and if efforts of the Central Transportation Planning Staff (CTPS) and the Chamber of Commerce are successful, workers in the Highland Ave.-Needham Street area will be getting to work with more ease, at less cost and congestion will be reduced.

At a meeting scheduled for GTE Sylvania at 3:00 p.m. on Monday, Oct. 5th, the entire program involving CTPS, the Chamber, the state's "Caravans" program (vanpooling) and more than 5,000 employees will begin. The basic steps involve individuals completing data cards on work locations, starting times, riding preferences, etc. which will be computerized and selected on a grid basis to match up with other riders going to the same general area, but (most likely) working for a different company.

Why It's Important

The program is important because funding cuts in state road building programs are delaying the Highland Ave.-Needham Street project, while business activity continues to mount in the area. Air quality measurements were taken earlier this spring as part of the demonstration project to determine correlations between reduced auto emissions and cleaner air as a result of a reduced number of employee vehicles in the area.

There are many incentives for both employees and employers to get involved, some of which are efficiency, safety, reduced time, lowered cost of commuting, reduction of tension and stress, absenteeism, sense of helping others, and most interestingly, reduced automobile insurance rates. Additional material will be discussed in future **Newton-Needham Business** issues.

JUDGE BASBAS MEETS WITH LAWYERS' COUNCIL

Twenty attorneys who are members of the Newton-Needham Chamber of Commerce met for dinner recently at the Holiday Inn to discuss ways in which they may cooperatively work for their community and develop their professional expertise.

Among the members are several who have established law practice locally, having moved out of downtown Boston locations. Several months ago a few of them got together and decided to pursue the possibility of organizing themselves within the Chamber. Atty. Donald Budge, who is also a member of the city's Board of Aldermen agreed to serve as Chairman *pro tem.* Assisted by a small steering committee which also included Attys. Paul Cronin, David Mofenson, Edward Richmond, Rober Tennant and Oscar Wasserman, they first determined the interest, professional expertise and law case preferences of the member attorneys within the Chamber and published the material for mutual use. Next it was decided to organize the Fall dinner, held recently and look into the possibility of establishing a business mediation panel. With the full cooperation of the Newton District Court Judge Monte G. Basbas a plan is now being developed to bring about such a program.

Judge Basbas, who addressed the group on the topic of protective custody of children petitions also urged the group to work with Boston College Law School students.

42 LEADERS BEGIN $7.5 THOUSAND CAMPAIGN

More than 40 key business leaders from Needham and Newton launched the 1981 Membership Development Campaign with a kickoff breakfast on Sept. 18. Larry Goldsmith, Senior Vice President of West Newton Savings Bank is serving as Chairman of the campaign. Dr. Bryan Carlson of Mount Ida Junior College, Chamber President for 1981 presided at the breakfast, which as at the Marriott.

A goal of $7,500 in new dues investment memberships has been set to expand programs, increase services and to replace member attrition. Assisting Goldsmith are four teams, each led by a captain as follows:

Richard Gagney, BayBank Middlesex *(captain)* and Raymond Ciccoli, Volvo Village & Village Chevrolet; Verne Edmunds, Andover-Newton Theological School; George Levy, Chandler-Levy Hardware; William Maurhoff, Mutual Bak for Savings; Richard Rando, BayBank Middlesex; Alan Schlesinger, Schlesinger & Buchbinder; Robert Stevens, Home Town Cooperative Bank; Robert L Tennant, R.L. Tennant Insurance and Walter Tennant, R.L. Tennant Insurance.

Michael Hammerschmidt, Ryan Elliott & Co. *(captain)* and Nathan Berkowitz, Fox & Hounds Properties; Robert Dwyer, Newton Buick; John Fox, Sylvania Products, C.S.D.; Francis L. Fryer, Jr., Guaranty-First Trust Co.; Stanley Golembe, Itek; Robert Horgan, Marriott Hotel; Stephen Karp, David Gerstenblatt & Associates; Paul Rubenstein, Security Mills Realty Trust and E. Jacqueline Wenz, Boston Gas Co

Stephen Pauler, Brodrick Bros. *(capt.)* and Peter Barber, Northland Investment Corp.; Philip Cacciatore, American Door Distributors; Louis DeAngelis, Aluminum Homes, Rand Engel, Home Energy Center, Inc.; Robert Freeto, Esq., Roy Mennell, Mennell Gallery of Homes; James A. Miller, Devco and Dewey Mollomo, Veterans Cab Co

Oscar A. Wasserman, Esq.; Wasserman & Feinberg *(captain)* and Kenneth Bleakney, Honeywell Information Systems, FED; Nancy Bristol, General Cinema Corp.; Harvey Cohen, D.M.D., Donald Budge, Esq., Thomas Henderson, Shawmut Community Bank; Richard F. Kaerwer; Victor A. Nicolazzo, Bigelow Oil Co.; Edward L Richmond, Esq. and Eugene A Tarsky, CPA

APPENDIX 7

SAMPLE PRESS RELEASE

(Name of Company Official) has announced that (company name) is participating in the Newton-Needham Commuter Program to encourage carpooling and vanpooling. The Program's goals are to reduce fuel consumption, unnecessary commuting expenses, traffic congestion and air pollution. This program is being jointly sponsored by the Newton-Needham Chamber of Commerce and Metropolitan Area Planning Council with funding from the U.S. Environmental Protection Agency.

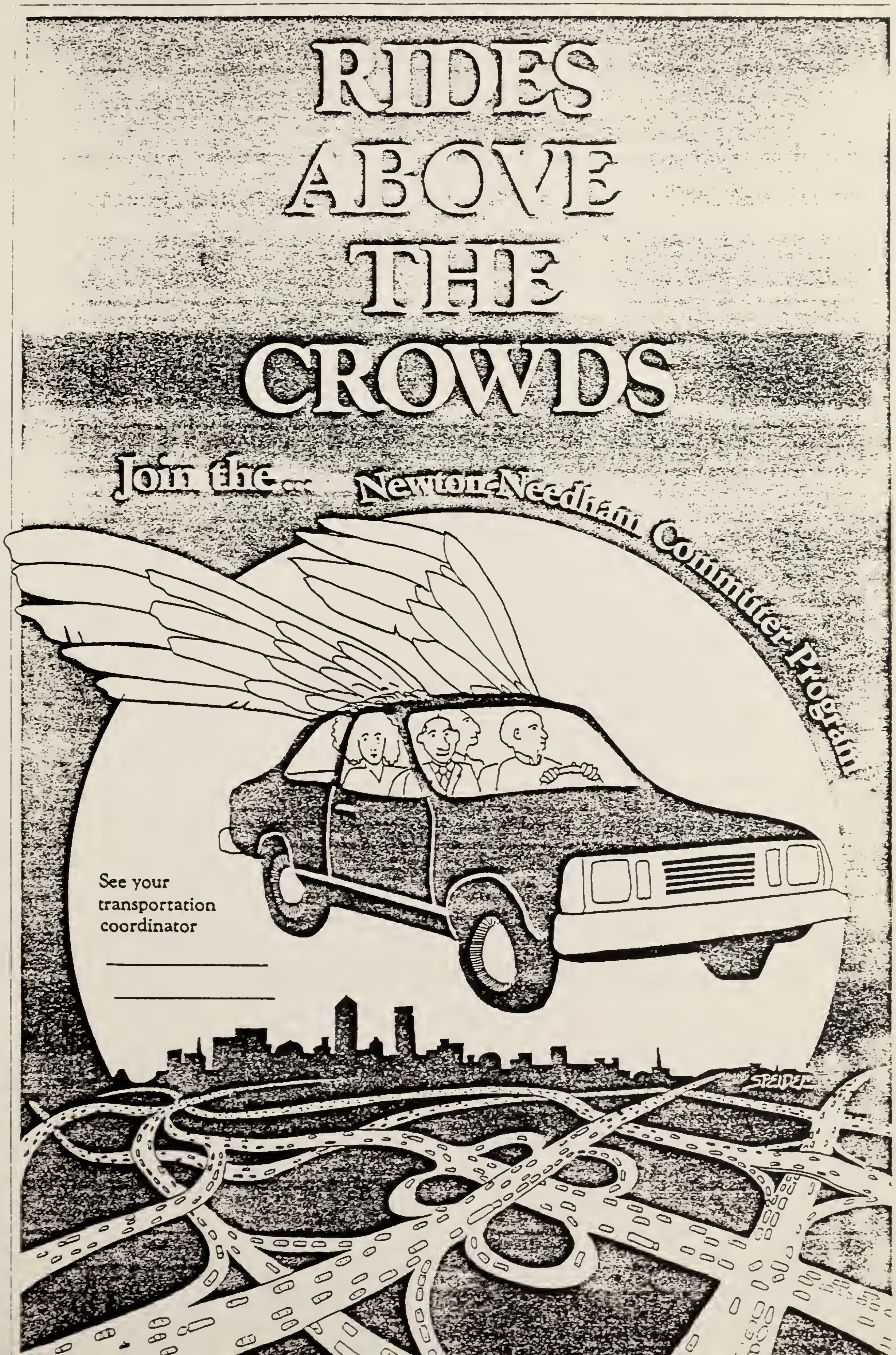
Carpooling and vanpooling simply involve getting together with fellow employees or other employees in the area to share private transportation to and from work. Carpooling and vanpooling are both voluntary programs, and decisions are strictly up to you at all times. According to (Company Official cited above), "(Quote)".

The first step to participate is to complete the questionnaire which will be made available to all employees. The information will be kept strictly confidential. A computerized matching system will be used to sort home locations and work schedules. The transportation coordinator, (coordinator's name), will then provide you with a special matching list with the names, work schedules, and contact telephone numbers of those who share your transportation needs. (Name of coordinator) will help you contact these potential poolers so that pools can be organized.

As an additional incentive to encourage carpooling we have (describe your incentive program here, e.g., reserved a number of parking spaces closest to company entrances for carpoolers).

The questionnaire should be completed even if you do not plan to join a carpool or vanpool to help develop better parking and public transportation service for everyone at the company. Please return the questionnaire to (name of coordinator) by Tuesday, October 27.

APPENDIX 8


RIDES ABOVE THE CROWDS
Join the...
Newton-Needham Commuter Program!
See your transportation coordinator
SPEIDEL

APPENDIX 9

CTPS

central transportation planning staff
27 school street boston massachusetts 02108 (617) 451-5785

MEMORANDUM

TO: Files December 17, 1981

FROM: Bob Reyes

RE: Newton-Needham Commuter Program

The Newton-Needham Commuter Program is the multi-employer ridesharing program, which is now being implemented under the sponsorship of CTPS, MAPC and CARAVAN. CTPS and MAPC focus their efforts on carpooling; CARAVAN is responsible for van-pooling. This program is the principal strategy aimed at reducing auto travel in the Newton-Needham industrial/office area. The program is part of the RACMs program, funded by the U. S. Environmental Protection Agency.

In October 1981, roughly 5,000 ridesharing forms were distributed to 15 participating employers in the Newton-Needham industrial/office area. From this effort, a pool of 750 employees was formed; 450 of these are actively interested in ridesharing. These 450 employees have been matched with one another, where possible, and they have been provided with lists of people living in their neighborhood who share their commute to work.

Denny Lawton of MAPC and Bob Reyes of CTPS convened a follow-up meeting to discuss their experience in Newton/Needham with other individuals interested in and experienced with ridesharing. Those who attended the meeting and their organizational affiliation are listed below:

- o Bob Reyes, CTPS
- o Lew Songer, Newton-Needham Chamber of Commerce
- o Joyce Hals, Massport
- o Alex MacArthur, New England Telephone
- o Jean Amato, CARAVAN
- o Bob Efraimson, Polaroid Corporation
- o Denny Lawton, MAPC

The discussion started with some statistics concerning the Newton/Needham program. Denny and Bob then solicited ideas concerning why more employees in the area might have

chosen not to participate. Several ideas were advanced. First, the current economic recession has provoked layoffs at many industrial plants. This, in turn, has created anxiety among employees and an unwillingness to try a new personal transportation concept, since some employees are uncertain about their job future. Second, at least one of the participating companies has a similar, but company-oriented, ride-sharing program. Thus, this program may seem redundant. Finally, some employees are dubious of any program which comes from or has the support of management.

All those at the meeting supported the idea if a follow-up effort. To this end, a meeting is being called for Tuesday, January 19, 1982. The meeting will be held at the 3M facility in Needham. The transportation coordinators from each participating company, who implemented the first ridesharing effort, will be invited to this meeting. Their ideas about appropriate follow-up strategies will be encouraged.

One goal of the meeting is to learn what implementation strategies have worked (from those employers whose experience has been particularly successful). A second goal is to create a network among the various transportation coordinators so that information continues to be shared in the future.

If the participants agree, some individual follow-up will be undertaken. Specifically, a random sample of individuals from the master matching list will be chosen. Each selected person will be asked about his/her specific experience; one product of this follow-up will be an estimate of the number of carpools and vanpools formed because of this program.

BR:sb

APPENDIX 10

mapc Metropolitan Area Planning Council 110 Tremont St., Boston, MA 02108 617/451-2770

LETTER SENT OUT TO TRANSPORTATION
COORDINATORS IN THE NEWTON AND
NEEDHAM AREAS

December 17, 1981

The Newton-Needham Commuter Program is underway. Thanks to your active involvement we have received over 750 data cards and have succeeded in matching over 400 employees in the Newton-Needham area into carpools or vanpools. We are hopeful that the results will benefit the participants as well as contribute to alleviating the traffic problems along Highland Avenue and Needham Street.

As we have discussed with you, this project is not intended to be a "one-shot" effort. Although the results of the first round were positive, particularly in this period of stable gas prices and plentiful supplies, we feel that additional participation is possible now that the feasibility of the matching process has been demonstrated.

For this reason, we and the Newton-Needham Chamber of Commerce would like to reconvene a meeting of the Transportation Coordinators on Tuesday, January 19 at 10:30 a.m. at the office of the 3M Company, 155 Fourth Avenue, Needham Heights. The purpose of this meeting will be to discuss the results of the program so far, the feasibility of continuing the matching efforts, additional incentives that might be considered, and ways in which participation might be increased at a minimum effort. We hope you will be able to attend. If not, an alternate representative can be appointed to attend in your place. We look forward to seeing you on January 19.

Have a happy holiday season.

Sincerely,

Denny Lawton
Transportation Planner, MAPC

Bob Reyes
Principal Planner, CTPS

APPENDIX 11

mapc Metropolitan Area Planning Council 110 Tremont St., Boston, MA 02108 617/451-2770

January 26, 1982

TO: Newton-Needham Commuter Program Transportation Coordinators
FROM: Denny Lawton, MAPC
SUBJ: Minutes of the January 19, 1982 Transportation Coordinators Meeting

On January 19 a meeting was held at the offices of the 3M Company, Needham Heights, to discuss the initial computerized matching effort and what further activities should be pursued to continue the ridesharing program. In attendance were:

Virginia Sexton, Damon Corporation
John Fox, GTE Sylvania
William Thornton, 3M Company
C.R. Ryan, Itek Measurement Systems
Robert Efraimson, Polaroid Corporation
Jeanne Amato, Caravan
Avis Feldman, Caravan
Lewis Songer, Newton-Needham Chamber of Commerce
Bob Reyes, CTPS
Denny Lawton, MAPC

Bob Reyes opened the meeting by discussing the results of the initial matching effort. Bob explained the density matrices which indicate the density of employee home origins based on work starting time and ridesharing interest. The various cross-tabulations of answers to the matching questionnaire were also discussed.

Bill Thornton of 3M then described the procedures used at the 3M Company for promoting the Commuter Program and distributing the matching questionnaires. Posters were hung prior to distribution of the cards. Bill then met with individual supervisors, explaining the program's benefit to their employees and to the area as a whole. As necessary, Bill met directly with employees to explain the program. C.R. Ryan of Itek made an effort to follow-up on all non-returns to encourage those who did not complete the form to do so. Based on the discussion it was apparent that higher returns were the result of greater involvement of the transportation coordinator.

Denny Lawton discussed the meeting of December 8 at which a number of interested people who were either involved with the Newton-Needham project or ridesharing programs elsewhere met to evaluate the initial results of the matching effort. It was agreed at this meeting that although the participation rate was less than hoped for, that the results were reasonable given the current availability and pricing of gasoline. Furthermore, recent cutbacks in the area's employment and the prospect of future layoffs have created a sense of insecurity among many employees that could reduce their willingness to make commitments, such as forming a carpool, with other employees. Some area companies already operate an in-house carpool matching service which could be viewed by employees as being redundant. Additionally, some employees may be skeptical of any program presented to them by their management. The

December 8 meeting concluded with a discussion of further incentives and program refinements that could be applied to a renewed effort in the Newton-Needham area.

Following Denny's presentation was an open discussion concerning the future of the program and what impact it has had so far. It was generally agreed that further activities were warranted. Lew Songer said that if a ridesharing task force were to be organized that it could be a sub-committee of the existing Chamber of Commerce Highland Avenue-Needham Street Task Force.

John Fox of GTE Sylvania felt that the size of the GTE operation made it unnecessary for their employees to be matched with employees outside of the company. John felt most of GTE's carpooling was internal and there would be no interest in matching with other companies. He also indicated that some of the matches that were made through the program were not accurate in terms of their geography. John felt that due to a trend toward smaller cars that the average size of carpools is shrinking, favoring two-person pools. Because only one other person is involved besides the driver, it is easy to manually arrange to pool. GTE currently provides this service to all new employees.

Bob Efraimson felt that carpooling should be promoted as a contingency option that would be available if an employee is somehow prevented from getting to work on his own, as in the event of an injury or automobile problems. Bob felt that wide-scale carpool/vanpool matching programs do not generally get big results and that this program should be modified. Not every company needs a transportation coordinator. Bob also felt that the Chamber of Commerce should provide a central phone number to call in order to update the matching files.

Jeanne Amato then discussed how CARAVAN will proceed to develop vanpools in the Newton-Needham area. Jeanne will arrange meetings of interested employees at various locations and asked for the cooperation of the transportation coordinators in distributing informational materials, posting meeting announcements, and allowing employees time off from their job in order to attend an organizational meeting.

It was then agreed that there should be a second round of the matching effort but with some changes. Smaller companies and those particularly in the Wells Street area should be encouraged to participate. Personnel departments should be distributing matching questionnaires to "new hires" as part of their orientation program and information on terminations should be obtained in order to keep files updated. This information could be made available through mail room supervisors. Furthermore, a follow-up written random survey of previous respondents should be undertaken on a limited scale in order to ascertain how well the program has been working and whether those people matched into pools have followed through and are now pooling.

Winter was not considered a good time to renew the program and there was a general consensus that it should take place in the spring. In the meantime, transportation coordinators should be sent a copy of the minutes of this meeting and the Chamber of Commerce and MAPC/CTPS should encourage additional companies to participate.

The next meeting of the transportation coordinators was tentatively scheduled for mid-March to be held at the Polaroid Company. Bob Efraimson agreed to make a short presentation on the Polaroid operation in Needham at the beginning of the meeting.

APPENDIX 12

mapc Metropolitan Area Planning Council 110 Tremont St., Boston, MA 02108 617/451-2770

February 11, 1982

Dear Transportation Coordinator:

A general meeting of transportation coordinators from businesses in the Newton-Needham industrial area was held on March 16, 1982. The minutes of that meeting are included here for your information. At that meeting, it was decided that there should be one more attempt to sign up commuters in the Newton-Needham Commuter Program.

As you are aware, the program attempts to encourage ride-sharing in the Newton-Needham industrial area. The formation of carpools and vanpools among employees is encouraged by matching people who now hold their commute in common. This matching is done by computer from information provided by interested employees on Newton-Needham Commuter Program cards.

The initial response, provided from our October 1981 effort, has produced a pool of 450 potential ridesharers. Even more people could be matched from our data pool of 750 commuters, if more people were encouraged to actively participate.

Getting more commuters to actively participate in the program is the point of this letter. We would like to sponsor a final sign-up effort for the commuter program. A meeting has been called for Tuesday, March 16, 1982, at 10 AM. It will be held at Polaroid, 151 Third Avenue, Needham Heights. At this meeting, we hope to assess interest in and commitment to this final effort.

The success of this effort depends on you. So, we hope you will make a special attempt to attent this meeting.

Sincerely,

Bob Reyes
Principal Planner

Denny Lawton
Transportation Planner

BR:DL:sb

Enclosures

APPENDIX 13

NEWTON-NEEDHAM TRANSPORTATION PROJECT

EMPLOYER'S SURVEY

Date: ____________________

1.) Name of Firm: ________________________________

Address: ________________________________

____

____

Briefly describe the nature of your business:

____

____

____

2.) Name of Personnel Director: ____________________ Phone #: ______________

Contact Person if not Personnel Director: ________________ Phone #: _____

3.) Total Number of Employees: ____________________

Number of Employees by category:

Office/Clerical: ______________________

Manufacturing: ______________________

Other (please describe): ______________________________________

____

____

4.) Number of Work Shifts: ____________________

Hours of Work Shifts: ____

____

5.) Using the information from Questions #3 and #4, please complete the following matrix: (page 2)

Number of Employees:

Hours of Shifts	Office/Clerical	Manufacturing	Other

6.) Does your firm utilize flexible work hours, a shortened work week or sliding shifts?

Please circle: Yes No

If no, go to Question #7.

If yes, please describe: ______________________________

____

____

____

____

Which employees are eligible to participate? ______________________________

____

____

How well is it working? ______________________________

____

____

7.) How do your employees travel to and from work?

	%
Car	
Public Transit	
Walk	
Bike	
Taxi	

8.) Where are the nearest bus stops to your plant? ____________________

____

____

9.) Please describe available employee parking facilities:
(Include a sketch of lot layout if possible.)

____

____

____

How many spaces are available: ____________________________

Are there any particular problems regarding parking availability?

____

____

____

Does your firm have special parking policies (i.e. Executive Parking Only area, carpooling area, etc.)? Please describe: ______________

____

____

____

10.) Has your firm ever promoted employee participation in ridesharing programs?

Please circle: Yes No

If yes, please describe the program and evaluate its level of success:

____

____

____

What percentage of your employees would you estimate to carpool presently?

_____ %

11.) How might increased ridesharing be beneficial to your firm? ________

____

____

____

Do you have any ideas concerning what type of ridesharing program(s) might be most successful at your firm? ________________

____

____

____

Would you or your staff be available to assist in the promotion of a ridesharing program?

Please circle: Yes No

THANK YOU FOR YOUR TIME AND ASSISTANCE!

APPENDIX 14

NEWTON - NEEDHAM COMMUTER PROGRAM

Employer's Survey

Name of Firm	Number of Employees Office/ Clerical	Non-Office/ Manufacturing	Total	Offers Flexible Work Hours	Problems in Parking Availability	Previous Ridesharing Promotion	Willing to Promote Ridesharing
GTE Sylvania Needham	1542	300 58 part time	1900	No	No	Yes	Yes
Damon Corp. Needham	420	180	600	No	No	Yes	Yes
Polaroid Corp. Needham	250	150	400	No	No	Yes	Yes
Coca Cola Co. of N.E. Needham	49	249 86 Sales	384	No	No	Yes	No
Balco, Inc. Newton	100	250	350	No	Yes	No	Yes
St. Regis Paper Co. Newton	100	214	314	No	No	Yes	Yes
NRC, Inc. Newton	50	150 10 Sales	210	Yes	No	Yes	Yes

NEWTON - NEEDHAM COMMUTER PROGRAM

Employer's Survey

Name of Firm	Number of Employees Office/ Clerical	Non-Office/ Manufacturing	Total	Offers Flexible Work Hours	Problems in Parking Availability	Previous Ridesharing Promotion	Willing to Promote Ridesharing
LTX Corp. Newton	20	160	180	No	No	No	"Not Sure"
IMLAC Corp. Needham	30	40 40 Engineers	110	No	No		Yes
Tenneco Chemicals, Inc. Newton	26	60	86	No	No	No	Yes
Itek Measurement Sys. Newton	15	60 10 Other	85	No	No	Yes	Yes
Impact Sales Co., Inc. Needham	41	22	63	No	"Tight"	No	
McDonald's Newton		54 part time 6 management	60	No	No	No	No
3M Needham	43	16	59	No	No	Yes	Yes

NEWTON - NEEDHAM COMMUTER PROGRAM

Employer's Survey

Name of Firm	Number of Employees Office/ Clerical	Non-Office/ Manufacturing	Total	Offers Flexible Work Hours	Problems in Parking Availability	Previous Ridesharing Promotion	Willing to Promote Ridesharing
Continental Broadcasting Network (WXNE) Needham	13	44	57	Yes	No	No	Yes
Union Carbide Corp. Needham	11	35	46	No	No	Yes	No
General Elec. Co. Newton	14	9 22 Sales	45	Yes	No	No	Yes
Allen Furniture Needham	12	5 15 Sales	32	No	No	No	No
Valco Co., Inc. Needham	2	4	6	No	No	No	No
Kentco Corp. Needham			5				
Eugene Tarsky, CPA Newton	5		5	Yes	No	No	No

NEWTON - NEEDHAM COMMUTER PROGRAM

Employer's Survey

Name of Firm	Number of Employees Office/ Clerical	Non-Office/ Manufacturing	Total	Offers Flexible Work Hours	Problems in Parking Availability	Previous Ridesharing Promotion	Willing to Promote Ridesharing
American Door Dist., Inc. Needham	5	21	26	No		Yes	No
Fowler Printing Co. Needham	6	14 3 Sales	23	Yes	Unauthorized Yes	Yes	No
Automatic Sprinkler Corp. Newton	2	8 4 Sales	14	Yes	No	Yes	No
Upper Falls Liquors Newton		12	12	Yes		No	No
Boy on a Dolphin Restaurant Newton		11	11	No	No	No	No
Harlow-Imrie Corp. Newton	6	3	9	No	Unauthorized Yes	Yes	No
Hilton-Walker and Co. Newton	4	5	9	Yes	No	Yes	No

NEWTON - NEEDHAM COMMUTER PROGRAM

Employer's Survey

Name of Firm	Number of Employees Office/ Clerical	Non-Office/ Manufacturing	Total	Offers Flexible Work Hours	Problems in Parking Availability	Previous Ridesharing Promotion	Willing to Promote Ridesharing
S.E.M. Co., Inc. Newton	3	2 Sales	5	No	No	No	No
Fox and Hounds Properties Newton	1	3 Brokers	4	No	No	No	No
Mike Mack Corp. Newton	4	5 Laborers	9	No	No	No	No
Malba, Inc. Newton		3 Plumbers	3				
Honeywell, Inc. Newton			800±				
NCR, Inc.			200±				
Merck, Sharp and Dohne Needham	14	15	29	No	No	No	No

NEWTON - NEEDHAM COMMUTER PROGRAM

Employer's Survey

Name of Firm	Number of Employees Office/ Clerical	Non-Office/ Manufacturing	Total	Offers Flexible Work Hours	Problems in Parking Availability	Previous Ridesharing Promotion	Willing to Promote Ridesharing
Scott Electrical Supply, Co. Inc. Needham	3	4	7	No	No	No	No

APPENDIX 15

TABLE 1

NEWTON - NEEDHAM RAMPS

COMPARISON OF 1981 & 1982 TRAFFIC DATA

HIGHLAND AVENUE EXIT 1st & 2nd OFF SOUTHBOUND NEEDHAM

TIME INTERVAL	1981 MDPW COUNT	1982 MDPW COUNT	1981 FACTORED COUNT	1982 FACTORED COUNT	% ∆ 1981-1982 $\left(\frac{4-3}{3}\right)$
12-1 AM	213	171	153	134	
1-2	[illegible]	70	68	55	
2-3	52	43	37	35	
3-4	29	23	21	18	
4-5	29	27	21	21	
5-6	84	73	60	57	
6-7	301	305	217	230	
7-8	916	853	660	668	
8-9	1141	1010	822	836	
9-10	[illegible]	[illegible]	[illegible]	721	
10-11	1021	[illegible]	735	775	
11-12	1129	1155	856	[illegible]	
12-1 PM	1333	1257	963	984	
1-2	1333	1204	960	1013	
2-3	1324	1315	953	1030	
3-4	1693	1714	1219	1342	
4-5	2350	2110	1692	1652	
5-6	2085	1892	1501	1474	
6-7	1371	1139	987	892	
7-8	919	825	662	646	
8-9	[illegible]	622	517	487	
9-10	676	563	487	441	
10-11	469	383	338	300	
11-12	353	319	254	250	
	20447	19205	14281	15039	+ [illegible]

TABLE 2

NEWTON - NEEDHAM REGION'S

COMPARISON OF 1981 & 1982 TRAFFIC DATA

HIGHLAND AVENUE BET. 1ST - 2ND AVENUES, NEEDHAM NORTHBOUND

Time Interval	1981 MDPW Count	1982 MDPW Count	1981 Factored Count	1982 Factored Count		% age Δ 1981 - 1982 $\left(\frac{4-3}{3}\right)$
12-1 AM	119	129	68	87		+ 28
1-2	53	43	30	34		+ 13
2-3	33	13	19	14		− 26
3-4	23	16	13	13		0
4-5	54	46	31	37		+ 19
5-6	179	145	102	116		+ 14
6-7	1103	823	627	658		+ 5
7-8	2280	1669	1295	1335		+ 3
8-9	2524	1874	1434	1499		+ 5
9-10	1625	1310	923	1048		+ 14
10-11	1422	1126	808	901		+ 12
11-12	1603	1247	911	993		+ 10
12-1 PM	1872	1397	1063	1118		+ 5
1-2	1740	1354	988	1083		+ 10
2-3	1565	1210	889	974		+ 10
3-4	1580	1265	897	1014		+ 13
4-5	1628	1160	925	928		0
5-6	1436	1097	816	878		+ 8
6-7	1119	816	636	653		+ 3
7-8	940	645	534	516		− 3
8-9	649	424	369	387		+ 5
9-10	518	396	294	317		+ 8
10-11	381	306	216	245		+ 13
11-12	259	208	147	166		+ 13
			14035	15019		+ 7.0

TABLE 3

NEWTON - NEEDHAM RADIAL'S

COMPARISON OF 1981 & 1982 TRAFFIC DATA

NEEDHAM ST., S. OF WINCHESTER ST., NORTHBOUND NEWTON

TIME INTERVAL	1981 MDPW COUNT	1982 MDPW COUNT	1981 FACTORED COUNT	1982 FACTORED COUNT	% CHANGE Δ 1981-1982 $\left(\frac{2-1}{1}\right)$
12-1 AM	74	42			
1-2	47	45			
2-3	13	19			
3-4	14	17			
4-5	25	30			
5-6	47	74			
6-7	328	370			
7-8	548	679			
8-9	720	840			
9-10	624	767			
10-11	617	764			
11-12	753	837			
12-1 PM	860	936			
1-2	870	957			
2-3	757	892			
3-4	870	1037			
4-5	971	1143			
5-6	1013	1120			
6-7	774	914			
7-8	582	659			
8-9	427	529			
9-10	349	419			
10-11	233	283			
11-12	149	212			
ADT	11704	13705			

TABLE 4

NEWTON - NEEDHAM RADIAL'S

COMPARISON OF 1981 & 1982 TRAFFIC DATA

NEEDHAM ST. S/O WINCHESTER ST. [illegible] NEWTON

TIME INTERVAL	1981 MDPH COUNT	1982 MDPH COUNT	1981 FACTORED COUNT	1982 FACTORED COUNT		% AGE Δ 1981-1982 (2-1)/1
12-1 AM	47	44				
1-2	40	33				
2-3	23	26				
3-4	13	14				
4-5	15	22				
5-6	70	63				
6-7	316	336				
7-8	742	733				
8-9	836	910				
9-10	604	736				
10-11	591	711				
11-12	649	749				
12-1 PM	643	848				
1-2	603	915				
2-3	772	862				
3-4	756	951				
4-5	745	815				
5-6	760	794				
6-7	654	735				
7-8	464	535				
8-9	381	462				
9-10	355	382				
10-11	260	265				
11-12	154	153				
AADT	10994	12182				+ 10.[illegible]

Sheet 5

Newton - Needham Bridges

Comparison of 1981 & 1982 Traffic Data

Kendrick Street @ Charles River, Eastbound

Time Interval	1981 MDPW Count	1982 MDPW Count	1981 Factored Count	1982 Factored Count	% Inc. 1981-1982 (2-1)
12-1 AM	29	44			
1-2	10	11			
2-3	3	8			
3-4	3	4			
4-5	4	2			
5-6	14	26			
6-7	131	162			
7-8	710	747			
8-9	1079	1180			
9-10	430	504			
10-11	284	346			
11-12	317	340			
12-1 PM	369	395			
1-2	391	418			
2-3	365	383			
3-4	437	493			
4-5	578	565			
5-6	452	486			
6-7	260	263			
7-8	166	179			
8-9	108	125			
9-10	85	100			
10-11	61	69			
11-12	59	64			
	6411	6914			+ 7.8

TABLE 6

NEWTON - NEEDHAM BRIDGES

COMPARISON OF 1981 & 1982 TRAFFIC DATA

KENDRICK STREET @ CHARLES RIVER, : WESTBOUND

TIME INTERVAL	1981 MONTH COUNT	1982 MONTH COUNT	1981 FACTORED COUNT	1982 FACTORED COUNT	% DIFF 1981-1982 (—)
12-1 AM	52	39			
1-2	13	11			
2-3	5	8			
3-4	2	4			
4-5	5	6			
5-6	16	23			
6-7	190	228			
7-8	530	497			
8-9	635	545			
9-10	325	295			
10-11	283	293			
11-12	361	384			
12-1 PM	497	495			
1-2	435	441			
2-3	456	463			
3-4	570	556			
4-5	813	876			
5-6	977	943			
6-7	397	404			
7-8	230	224			
8-9	162	142			
9-10	152	129			
10-11	98	117			
11-12	67	61			
	7271	7184			- 1.2

TABLE 7

NEWTON - NEEDHAM RAMPS

COMPARISON OF 1981 & 1982 TRAFFIC DATA

SECOND AVENUE @ HIGHLAND AVE., NORTHBOUND

TIME INTERVAL	1981 MDPW COUNT	1982 MDPW COUNT	1981 FACTORED COUNT	1982 FACTORED COUNT		% Δ 1981-1982 ((4-3)/3)
12-1 AM	36	30	24	28		
1-2	17	7	11	7		
2-3	9	9	6	9		
3-4	7	2	5	2		
4-5	12	9	8	9		
5-6	25	27	17	26		
6-7	98	103	66	98		
7-8	379	321	256	304		
8-9	467	332	315	314		
9-10	370	267	250	253		
10-11	334	262	225	248		
11-12	633	445	427	421		
12-1 PM	560	400	378	379		
1-2	431	312	291	295		
2-3	386	301	261	285		
3-4	793	613	535	581		
4-5	1408	893	950	846		
5-6	833	572	562	542		
6-7	397	227	268	215		
7-8	171	153	115	145		
8-9	95	68	64	64		
9-10	71	56	48	53		
10-11	51	37	34	35		
11-12	45	48	30	45		
			5146	5204		+1.1

TABLE 8

NEWTON - NEEDHAM RAMPS

COMPARISON OF 1981 & 1982 TRAFFIC DATA

SECOND AVENUE @ HIGHLAND AVE., SOUTHBOUND

TIME INTERVAL	1981 MARCH COUNT	1982 MARCH COUNT	1981 FACTORED COUNT	1982 FACTORED COUNT	% CHANGE 1981-1982 ((4-3)/3)
12-1 AM	8	15	7	16	
1-2	7	7	6	7	
2-3	4	2	4	2	
3-4	2	1	2	1	
4-5	8	9	7	10	
5-6	32	32	28	34	
6-7	274	265	240	282	
7-8	535	347	469	369	
8-9	430	401	377	426	
9-10	256	220	224	234	
10-11	220	184	193	196	
11-12	307	242	269	257	
12-1 PM	446	384	391	408	
1-2	397	323	348	343	
2-3	291	254	255	270	
3-4	237	198	208	210	
4-5	226	181	198	192	
5-6	189	156	166	166	
6-7	104	83	91	88	
7-8	96	66	84	70	
8-9	69	51	60	54	
9-10	46	48	40	51	
10-11	31	24	27	26	
11-12	22	18	19	19	
			3713	3731	+ 0.5

APPENDIX 16

Central Transportation Planning Staff

Sheet No 1 of 2
File No
Date 4/1/81
Comp By [illegible]
Chkd By

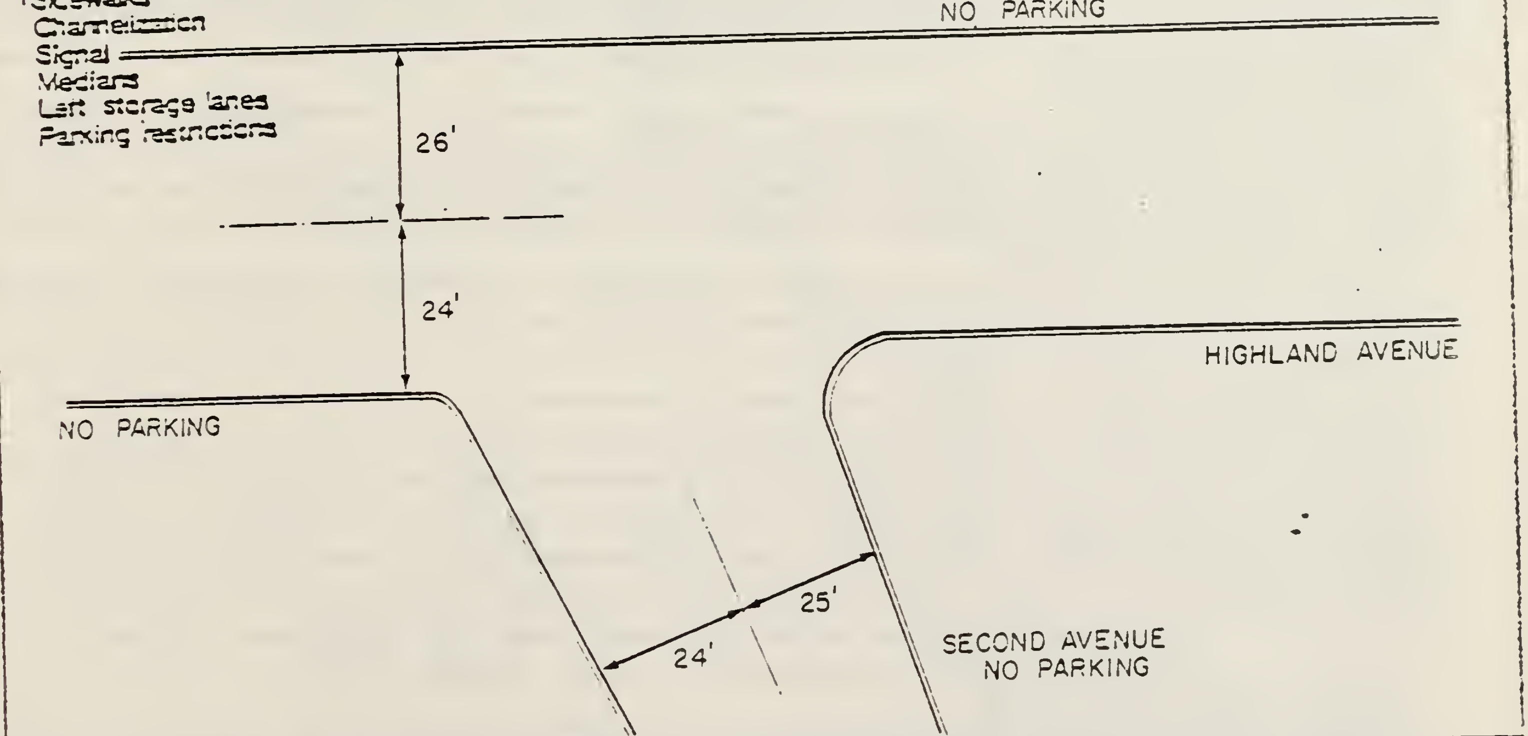
Project: NEWTON-NEEDHAM RADIALS
Subject: SECOND AND HIGHLAND AVENUES, NEEDHAM

GEOMETRIC SKETCH. PLAN

Existing/Proposed

INDICATE
- Right of way
- Pavement widths
- Pavement striping
- Sidewalks
- Channelization
- Signal
- Medians
- Left storage lanes
- Parking restrictions

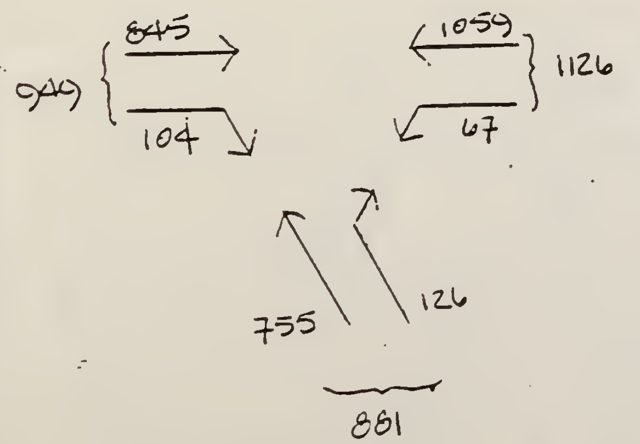
Indicate North



TRAFFIC VOLUMES (E/P)

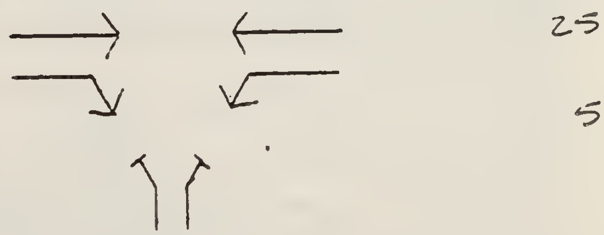
Date 3/10/81

$K = \frac{DHV}{ADT}$, K= __ %, (A.M., P.M.) 4:30-5:30

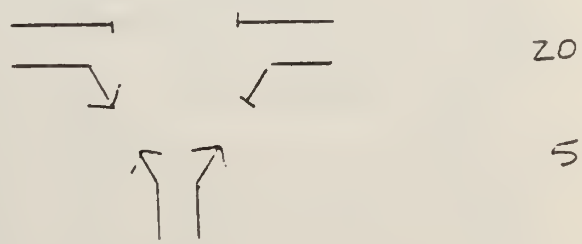


SIGNAL PHASING DIAGRAM

ϕ_1



ϕ_2



CENTRAL TRANSPORTATION PLANNING STAFF

CAPACITY ANALYSIS WORK SHEET

PROJECT TITLE RACM, Newton/Needham

INTERSECTION OF Second Avenue and Highland Avenue, Needham

Sheet No.	2 of 2
Project No.	
Date	4/1/81
Comp. By	Bob Reyes
Chk'd By	
Code No.	

GENERAL DESCRIPTION

Street Name & Direction	Highland SB	Highland NB	2nd Ave. NB		
Movements	S-L	S-R	L-R		
Phase	1	1	2		

PHYSICAL CONDITIONS

	4:30-5:30	4:30-5:30	4:30-5:30		
Parking within 250 feet?	NO-ONE-BOTH	NO-ONE-BOTH	NO-ONE-BOTH	NO-ONE-BOTH	NO-ONE-BOTH
One Way or Two Way	1 Way-2 Way	1 Way-2 Way	1 Way-2 Way	1 Way-2 Way	1 Way-2 Way
Approach or Lane Width	24'	24'	24'		

STANDARD APPROACHES

Location: CBD-F-CBD-R		6.5 6.6 6.7 6.8	6.5 6.6 6.7 6.8	6.5 6.6 6.7 6.8	6.5 6.6 6.7 6.8	6.5 6.6 6.7 6.8
Area Factor. Chart Used	fA	6.9 6.10 1.25	6.9 6.10 1.25	6.9 6.10 1.25	6.9 6.10	6.9 6.10
Pop ÷ 1,000=(1,000), PHF	fPPHF	1.19	1.16	1.09		

SPECIALIZED APPROACHES

L or R Turn Lane(No.Sep o)	17	G/C	G/C	G/C	G/C	G/C
L or R Low Typ.(Sep o)	18-A					
L or R High Typ.(Sep o)	18-B					
DBL L or R H.T.(Sep o)	18-D					
"T"or"Y"(incl. case type)	F-13	Fig. 13				
Special "T"(option lane)	F-12	V' =	V' =	V' =	V' =	V' =
Left Turn Advance Green	F-10	GDA	GDA	GDA	GDA	GDA
Other (Specify)						
For 18-D & F-13 only: Turning Angle	fA			60° 0.9		
For 18-D & F-13 only: Ent. Width	fWE			24' 0.8		

TRAFFIC CHARACTERISTICS

% Trucks	Table Used	fT	2% 6.6 1.03	2 6.6 1.03	2 6.6 1.03	6.6	6.6
% Lefts	Table Used	fL	6% 1.04	-	0% 1.10		
% Rights	Table Used	fR	NA 6.4 -	11% 6.4 0.995	14% 6.4 0.98	6.4	6.4
# Buses/Hr.	Table Used	fLB	NA	NA	NA		
INTERMEDIATE FACTOR $f_I = f_A \cdot f_{PPHF} \cdot f_A \cdot f_{WE} \cdot f_T \cdot f_L \cdot f_R \cdot f_{LB}$			1.593	1.486	1.089		

CALCULATIONS

Clearance Interval (sec)		Y	5	5	5		
Cycle Length (sec)		C	55	55	55		
DESIGN	Ratio	Y/C	0.55	0.55	0.64		
DESIGN	Intermed. S.V. (DSV·fI)	ISV	1690 | 2692	1690 | 2511	1690 | 1841		
DESIGN	Design Hr. Volume	DHV	1126	949	881		
DESIGN	Design G/C=DHV/ISV	DG/C	0.418	0.378	0.479		

Level of Service Determination Σ Y/C - Σ D G/C = From approp. Fig. L.O.S. =

Analysis Service Levels		A			A	B	C	A	B	C	D	E			
Green Interval (sec)	G	25			25			20							
Ratio	G/C	.50			.50			.409							
Composite Factor. fI G/C	fC	.797			.743			.445							
Chart Service Volume	CSV	1480			1480			1480	1550	1690	1930	2030			
Actual Service Volume	ASV	1180			1100			659	690	752	859	903			
Peak Hour Volume	PHV	1126			949			881			881	881			

COMMENTS OK@"D" OK@"A" NG NG NG NG OK@"E"

Central Transportation Planning Staff

Project: NEWTON-NEEDHAM RAMPS

Subject: SECOND AND HIGHLAND AVENUES, NEEDHAM

Sheet No 1 of 2

File No

Date

Comp By

Chkd By

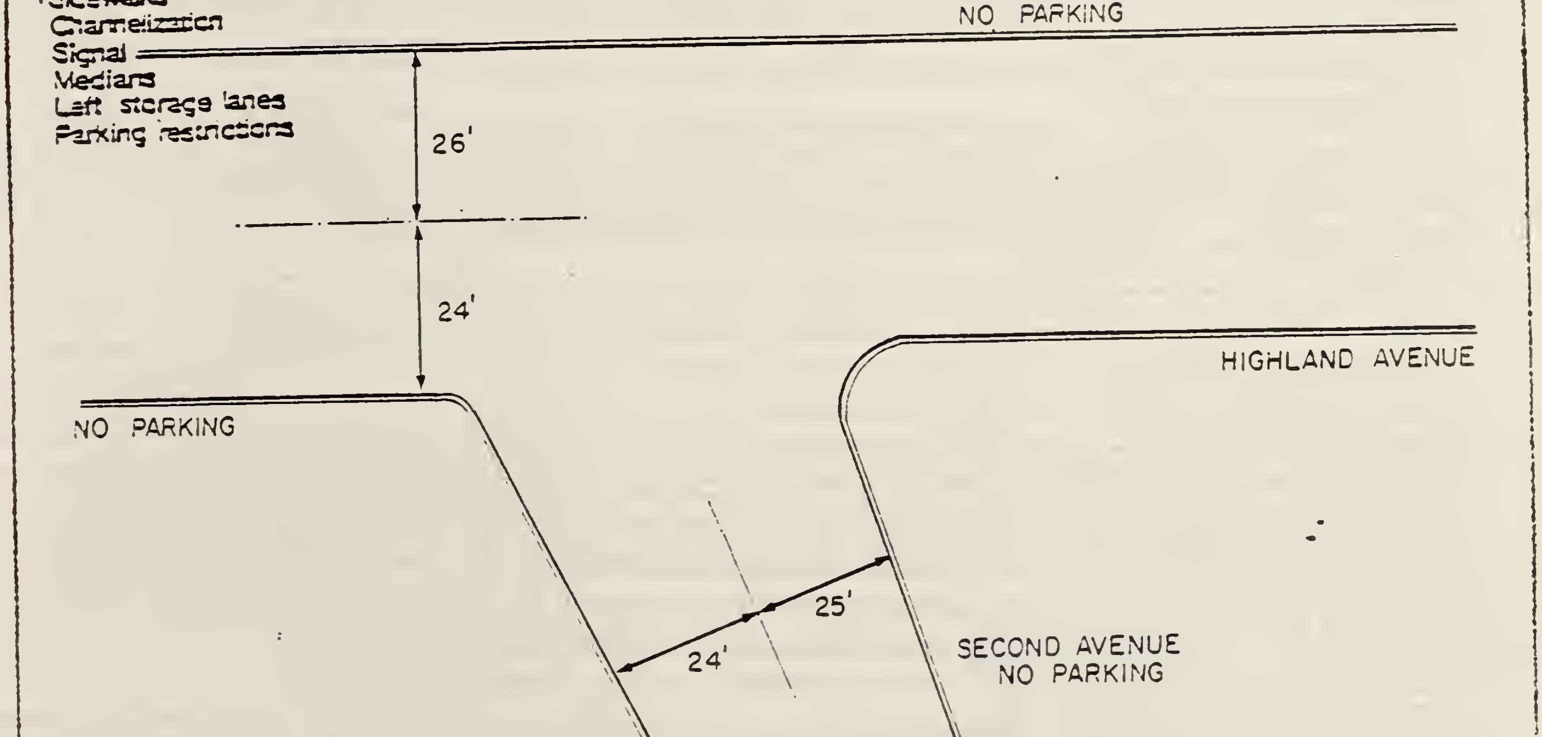
GEOMETRIC SKETCH. PLAN

Existing/Proposed

INDICATE

- Right of way
- Pavement widths
- Pavement striping
- Sidewalks
- Channelization
- Signal
- Medians
- Left storage lanes
- Parking restrictions

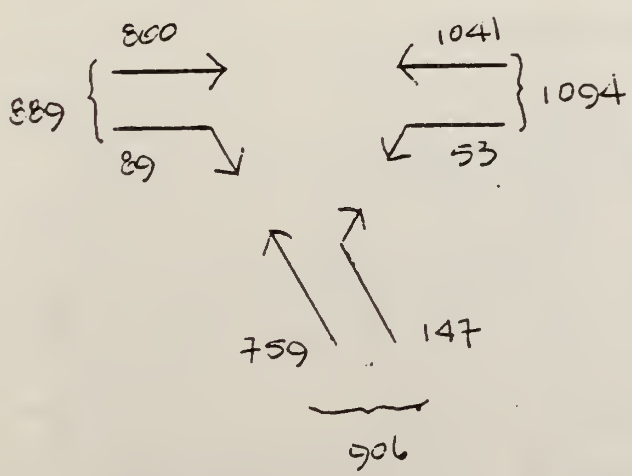
Indicate North



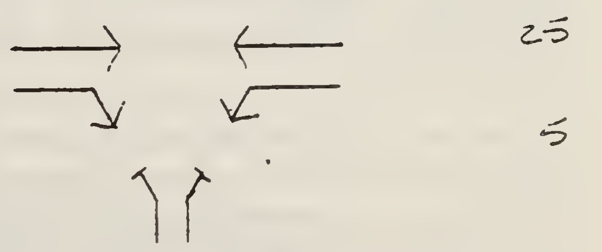
TRAFFIC VOLUMES (E/P)

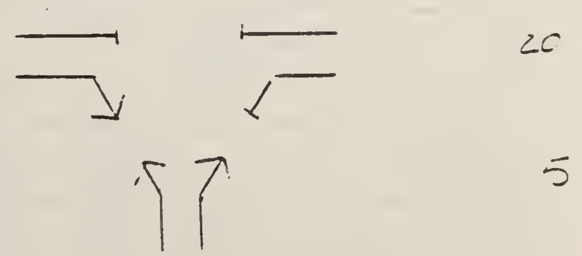
Date

$K=\frac{DHV}{ADT}$, K=__%, (A.M./P.M.) 4:30-5:30



SIGNAL PHASING DIAGRAM





CENTRAL TRANSPORTATION PLANNING STAFF		Sheet No.	2 of 2
CAPACITY ANALYSIS WORK SHEET		Project No.	
		Date	12/1/82
PROJECT TITLE	RACM, Newton/Needham	Comp. By	Bob Reyes
		Chk'd By	Bob Reyes
INTERSECTION OF	Second Avenue and Highland Avenue, Needham	Code No.	

GENERAL DESCRIPTION

Street Name & Direction	Highland SB	Highland NB	2nd Ave. NB		
Movements	S-L	S-R	L-R		
Phase	1	1	2		

PHYSICAL CONDITIONS

Parking within 250 feet?	NO-ONE-BOTH	NO-ONE-BOTH	NO-ONE-BOTH	NO-ONE-BOTH	NO-ONE-BOTH
One Way or Two Way	1 Way-2 Way	1 Way-2 Way	1 Way-2 Way	1 Way-2 Way	1 Way-2 Way
Approach or Lane Width	24'	24'	24'		

STANDARD APPROACHES

Location: CBD-F-CBD-R		6.5 6.6 6.7 6.3		6.5 6.6 6.7 6.3		6.5 6.6 6.7 6.3		6.5 6.6 6.7 6.3		6.5 6.6 6.7 6.3	
Area Factor. Chart Used	f_A	6.9 6.10	1.25	6.9 6.10	1.25	6.9 6.10	1.25	6.9 6.10		6.9 6.10	
Pop ÷ 1,000=( ), PHF	f_{POPPHF}	0.94	1.20	0.94	1.20	0.76	1.08				

SPECIALIZED APPROACHES

L or R Turn Lane (No. Sep o)	17	G/C		G/C		G/C		G/C		G/C	
L or R Low Typ. (Sep o)	18-A										
L or R High Typ. (Sep o)	18-B										
DBL L or R E.T. (Sep o)	18-C										
"T" or "Y" (incl. case type)	F-13					Fig. 13					
Special "T" (option lane)	F-12	V' =		V' =		V' =		V' =		V' =	
Left Turn Advance Green	F-10	C_{DA}		C_{DA}		C_{DA}		C_{DA}		C_{DA}	
Other (Specify)											
For 18-D & F-13 only: Turning Angle	f_A					60°	0.9				
For 18-D & F-13 only: Ent. Width	f_{WE}					24'	0.8				

TRAFFIC CHARACTERISTICS

	Table Used																
% Trucks	Table Used	f_T	2%	6.6	1.03	2%	6.6	1.03	2%	6.6	1.03		6.6			6.6	
% Lefts	Table Used	f_L	5%		1.05	NA		-	0%		1.10						
% Rights	Table Used	f_R	NA	6.4	-	10%	6.4	1.00	16%	6.4	0.97		6.4			6.4	
# Buses/Hr.	Table Used	f_{LB}															
INTERMEDIATE FACTOR $f_I=f_A \cdot f_{POPPHF} \cdot f_A \cdot f_{WE} \cdot f_T \cdot f_L \cdot f_R \cdot f_{LB}$			1.622			1.545			1.068								

CALCULATIONS

Clearance Interval (sec)	Y	5		5		5				
Cycle Length (sec)	C	55		55		55				
DESIGN: Ratio	Y/C	0.09		0.09		0.09				
DESIGN: Intermed. S.V. (DSV·f_I)	ISV	1690	2742	1690	2611	1690	1805			
DESIGN: Design Hr. Volume	DHV	1094		889		906				
DESIGN: Design G/C=DHV/ISV	DG/C	0.399		0.340		0.502				

Level of Service Determination Σ Y/C + Σ D G/C = From approp. Fig. L.O.S. =

Analysis Service Levels		A	B		A	B		A	B	C	D	E
ANALYSIS: Green Interval (sec)	G	25			25			20				
ANALYSIS: Ratio	G/C	.50			.50			.409				
ANALYSIS: Composite Factor, f_I G/C	f_C	.811			.773			.437				
ANALYSIS: Chart Service Volume	CSV	1480	1550		1480	1550		1480	1550	1690	1930	2030
ANALYSIS: Actual Service Volume	ASV	1200			1144			647	677	739	843	837
ANALYSIS: Peak Hour Volume	PHV	1094			889			906				
COMMENTS		OK@"A"			OK@"A"			NG	NG	NG	NG	NG

CENTRAL TRANSPORTATION PLANNING STAFF	Sheet No. 2 of 2
CAPACITY ANALYSIS WORK SHEET	Project No.
	Date 12/1/82
PROJECT TITLE: RACM, Newton-Needham	Comp. By Bob Reyes
	Chk'd By Bob Reyes
INTERSECTION OF: Second Avenue and Highland Avenue, Needham	Code No.

GENERAL DESCRIPTION

	Highland NB	Highland SB	2nd Ave. NB		
Street Name & Direction	Highland NB	Highland SB	2nd Ave. NB		
Movements	S-R	S-L	L-R		
Phase	1	1	2		

PHYSICAL CONDITIONS

Parking within 250 feet?	NO-ONE-BOTH	NO-ONE-BOTH	NO-ONE-BOTH	NO-ONE-BOTH	NO-ONE-BOTH
One Way or Two Way	1 Way-2 Way	1 Way-2 Way	1 Way-2 Way	1 Way-2 Way	1 Way-2 Way
Approach or Lane Width	24'	24'	24'		

STANDARD APPROACHES

Location: CBD-F-OBD-R		6.5 6.6 6.7 6.8		6.5 6.6 6.7 6.8		6.5 6.6 6.7 6.8		6.5 6.6 6.7 6.8		6.5 6.6 6.7 6.8	
Area Factor. Chart Used	fA	6.9 6.10	1.25	6.9 6.10	1.25	6.9 6.10	1.25	6.9 6.10		6.9 6.10	
Pop ÷ 1,000=( ), PHF	fPPHF	0.94	1.20	0.94	1.20	0.76	1.08				

SPECIALIZED APPROACHES

L or R Turn Lane(No.Sep φ)	17	G/C		G/C		G/C		G/C		G/C	
L or R Low Typ.(Sep φ)	18-A										
L or R High Typ.(Sep φ)	18-B										
DBL L or R E.T.(Sep φ)	18-D										
"T"or"Y"(incl. case type)	F-13			Fig. 13		Fig. 13		Fig. 13			
Special "T"(option lane)	F-12	V' =		V' =		V' =		V' =		V' =	
Left Turn Advance Green	F-10	C_{DA}		C_{DA}		C_{DA}		C_{DA}		C_{DA}	
Other (Specify)											
For 18-D & F-12 only: Turning Angle	f_A					60°	0.9				
For 18-D & F-12 only: Ent. Width	f_{we}					24'	0.8				

TRAFFIC CHARACTERISTICS

% Trucks	Table Used	f_T	2%	6.6	1.03	2%	6.6	1.03	2%	6.6	1.03		6.6			6.6
% Lefts	Table Used	f_L	NA		-	5%		1.05	0		1.10					
% Rights	Table Used	f_R	10%	6.4	1.00	NA	6.4		16%	6.4	0.97		6.4			6.4
# Buses/Hr.	Table Used	f_{LB}														
INTERMEDIATE FACTOR $f_I=f_A \cdot f_{PPHF} \cdot f_A \cdot f_{we} \cdot f_T \cdot f_L \cdot f_R \cdot f_{LB}$			1.545			1.622			1.068							

CALCULATIONS

Clearance Interval (sec)	Y	5		5		5				
Cycle Length (sec)	C	70		70		70				
DESIGN: Ratio	Y/C	0.063		0.063		0.063				
DESIGN: Intermed. S.V. (CSV·f_I)	ISV	1690	2611	1690	2742	1690	1805			
DESIGN: Design Hr. Volume	DHV	889		1094		906				
DESIGN: Design G/C=DHV/ISV	DG/C									

Level of Service Determination ΣY/C − ΣDG/C = From approp. Fig. L.O.S. =

Analysis Service Levels		A	B	A	B	C	D						
ANALYSIS: Green Interval (sec)	G	28		28		28							
ANALYSIS: Ratio	G/C	.436		.436		.493							
ANALYSIS: Composite Factor, f_I G/C	f_C	.674		.707		.527							
ANALYSIS: Chart Service Volume	CSV	1480	1550	1480	1550	1690	1930						
ANALYSIS: Actual Service Volume	ASV	998		1046	1096	891	1017						
ANALYSIS: Peak Hour Volume	PHV	889		1094		906							

OK@"A" OK@"B" OK@"D"

APPENDIX 17

Time (PM)	Motorcycles	Autos and Light Recreational Vehicles	Light Trucks	Two-Axle Diesel Trucks	Three and More Axle Diesel Trucks	Total 15-Minute Tally
3:45-4:00	1(0.2)*	413(82.8)	58(11.6)	21(4.2)	6(1.2)	499
4:00-4:15	1(0.2)	500(82.5)	77(12.7)	18(3.0)	10(1.7)	606
4:15-4:30		585(85.9)	71(10.4)	13(1.9)	12(1.8)	681
4:30-4:45		751(87.9)	69(8.1)	21(2.5)	13(1.5)	854
4:45-5:00		622(90.1)	53(7.7)	7(1.0)	8(1.2)	690
5:00-5:15		686(92.0)	48(6.4)	9(1.2)	3(0.4)	746
5:15-5:30		436(89.5)	45(9.2)	4(0.8)	2(0.4)	487
Total Vehicle Count	2(0.0)	3993(87.5)	421(9.2)	93(2.0)	54(1.2)	4563

*All figures in parentheses represent percentage of row totals.

NEWTON/NEEDHAM RACM'S PROJECT — VEHICLE CLASSIFICATION

HIGHLAND AND SECOND AVENUES, ALL TRAFFIC

TABLE 1

Time Interval (PM)	Motorcycles No.	Motorcycles %	Autos & Light Recreational Vehicles No.	Autos & Light Recreational Vehicles %	Light Trucks No.	Light Trucks %	Two Axle Diesel Trucks No.	Two Axle Diesel Trucks %	Three+ Axle Diesel Trucks No.	Three+ Axle Diesel Trucks %	Total 15 Minute Tally
3:30 - 3:45			672	(88.0)	70	(9.2)	11	(1.4)	11	(1.4)	764
3:45 - 4:00			495	(82.4)	69	(11.5)	27	(4.5)	10	(1.7)	601
4:00 - 4:15			570	(84.7)	75	(11.1)	18	(2.7)	10	(1.5)	673
4:15 - 4:30	1	(0.2)	540	(86.3)	63	(10.1)	14	(2.2)	9	(1.4)	626
4:30 - 4:45			667	(90.5)	55	(7.5)	10	(1.4)	5	(0.7)	737
4:45 - 5:00			704	(89.7)	63	(8.0)	6	(0.8)	12	(1.5)	785
5:00 - 5:15			681	(91.4)	51	(6.8)	8	(1.1)	5	(0.7)	745
5:15 - 5:30	—	—	677	(92.7)	38	(5.2)	6	(0.8)	9	(1.2)	730
	1	(0.2)	5,006	(88.4)	484	(8.5)	100	(1.8)	71	(1.3)	5,661

All figures in parentheses represent percentage of row totals.

TABLE 2

NEWTON/NEEDHAM RACM'S PROJECT VEHICLE CLASSIFICATION
SECOND AND HIGHLAND AVENUES, ALL TRAFFIC

Time (PM)	Motorcycles	Autos and Light Recreational Vehicles	Light Trucks	Two-Axle Diesel Trucks	Three and More Axle Diesel Trucks	Total 15-Minute Tally
3:45-4:00	1(0.3)*	271(83.1)	47(14.4)	5(1.5)	2(0.6)	326
4:00-4:15	1(0.3)	223(76.6)	51(17.5)	8(2.7)	8(2.7)	291
4:15-4:30		346(84.0)	53(12.9)	7(1.7)	6(1.5)	412
4:30-4:45		415(84.7)	53(10.8)	13(2.7)	9(1.8)	490
4:45-5:00		383(87.2)	46(10.5)	7(1.6)	3(0.7)	439
5:00-5:15		419(90.9)	36(7.8)	4(0.9)	2(0.4)	461
5:15-5:30		268(86.5)	38(12.3)	3(1.0)	1(0.3)	310
Total Vehicle Count	2(0.1)	2325(85.2)	324(11.9)	47(1.7)	31(1.1)	2729

*All figures in parentheses represent percentage of row totals.

NEWTON/NEEDHAM RACM'S PROJECT

VEHICLE CLASSIFICATION

HIGHLAND AND SECOND AVENUES, THROUGH TRAFFIC ON HIGHLAND AVENUE

TABLE 3

Time Interval (PM)	Motorcycles No.	Motorcycles %	Autos & Light Recreational Vehicles No.	Autos & Light Recreational Vehicles %	Light Trucks No.	Light Trucks %	Two Axle Diesel Trucks No.	Two Axle Diesel Trucks %	Three+ Axle Diesel Trucks No.	Three+ Axle Diesel Trucks %	Total 15 Minute Tally
3:30 - 3:45			412	(89.6)	43	(9.3)	3	(0.7)	2	(0.4)	460
3:45 - 4:00			375	(87.4)	40	(9.3)	11	(2.6)	3	(0.7)	429
4:00 - 4:15			403	(86.3)	48	(10.3)	10	(2.1)	6	(1.3)	467
4:15 - 4:30			355	(85.7)	47	(11.4)	7	(1.7)	5	(1.2)	414
4:30 - 4:45			403	(90.4)	39	(8.7)	3	(0.7)	1	(0.2)	446
4:45 - 5:00			405	(88.0)	47	(10.2)	4	(0.9)	4	(0.9)	460
5:00 - 5:15			414	(89.4)	42	(9.1)	4	(0.9)	3	(0.6)	463
5:15 - 5:30			434	(92.1)	29	(6.2)	4	(0.8)	4	(0.8)	471
TOTAL Vehicle Count	0		3,201	(88.7)	335	9.3	46	1.3	28	0.8	3,610

All figures in parentheses represent percentage of row totals.

Table 4

Newton-Needham RACM's Study — Vehicle Classification

Highland Avenue at Second Avenue, Highland Avenue Through Traffic Only

APPENDIX 18

TABLE 1

1981 MONITORING SEASON RESULTS

ONE HOUR CARBON MONOXIDE

One Hour Maximum / Carbon Monoxide

DAY (APRIL)		Time of Day (Hour)	One hr. Max.
Thursday	2	5-6PM	1.3
Friday	3	4-5PM	3.0
Saturday	4	12-1PM	0.5
*Sunday	5	0	0
Monday	6	4-5PM	2.3
Tuesday	7	7-8PM	3.5
Wednesday	8	10-11PM	2.0
Thursday	9	4-5PM	2.0
Friday	10	4-5PM	2.0
Saturday	11	2-3PM	0.8
Sunday	12	11-12AM	1.5
Monday	13	12-1PM	1.5
Tuesday	14	4-5PM	2.5
Wednesday	15	4-5PM	1.3
Thursday	16	4-5PM	2.0
Friday	17	11-12AM	2.0
Saturday	18	4-5AM	1.0
Sunday	19	11-12PM	3.0
Monday	20	12-1AM	2.5
Tuesday	21	4-5PM	0.8
Wednesday	22	11-12PM	3.0
Thursday	23	12-1AM	3.0
Friday	24	5-6PM	1.8
Saturday	25	9-10PM	1.3
Sunday	26	12-1AM	0.8
Monday	27	8-9PM	3.3
Tuesday	28	3-4PM	2.0
Wednesday	29	3-4PM	1.5

* Recorded values are well below .0 (.02) for the entire day-

SOURCE: DEQE

TABLE 2

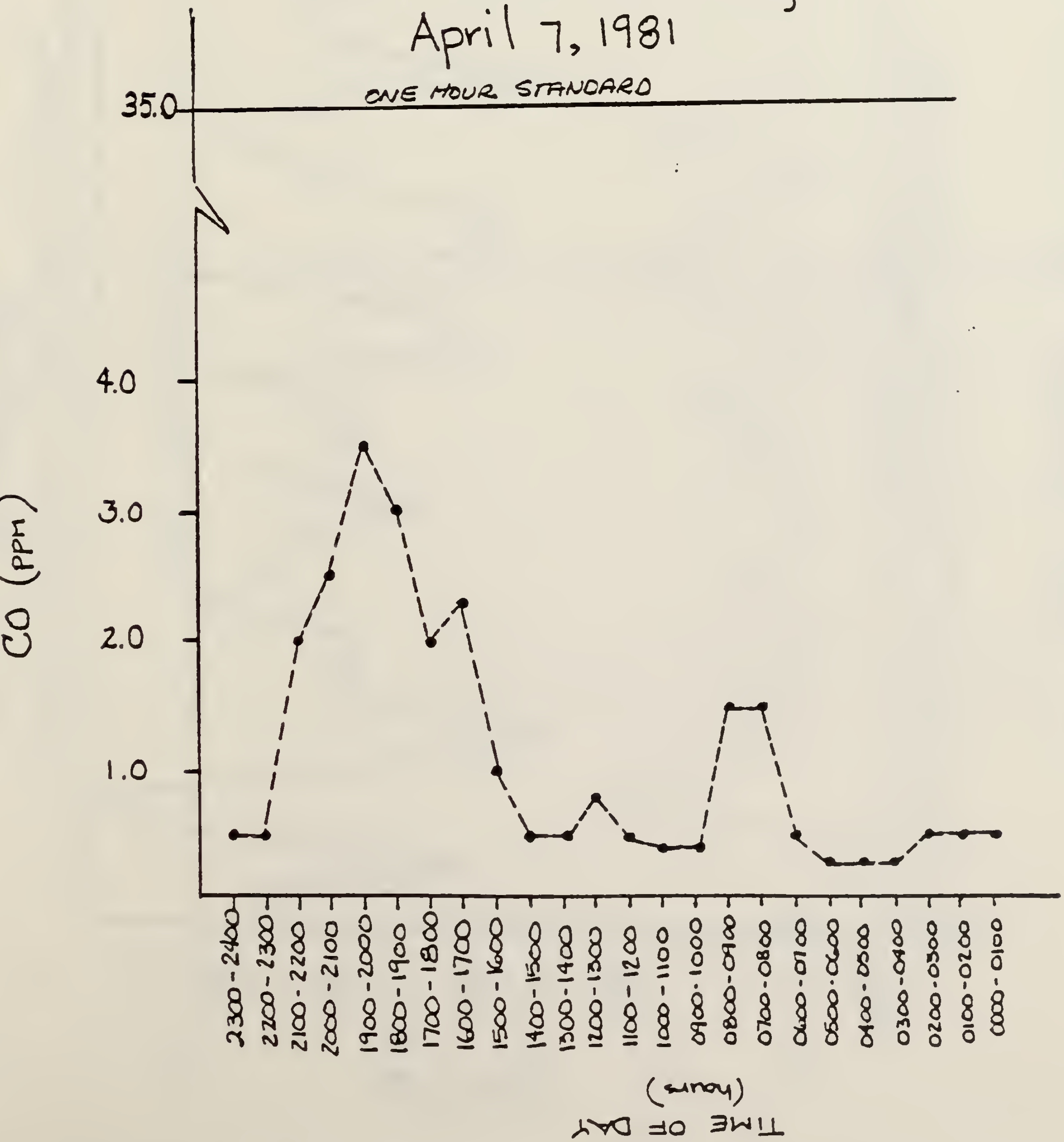
1981 Monitoring Season Results
Eight Hour Maximum/Carbon Monoxide

DAY (APRIL)		Time of Day (Hour)	Eight Hour Maximum
Thursday	2	3-11PM	1.0
Friday	3	11-7PM	1.0
Saturday	4	12-8AM	.4
* Sunday	5	0	0
Monday	6	11-7PM	1.6
Tuesday	7	2-10PM	2.4
Wednesday	8	10-6PM	1.4
Thursday	9	12-8PM	1.0
Friday	10	3-11PM	1.3
Saturday	11	2-10PM	0.8
Sunday	12	6-2AM	0.6
Monday	13	10-6AM	1.4
Tuesday	14	10-6PM	1.1
Wednesday	15	12-8PM	0.7
Thursday	16	10-6PM	0.7
Friday	17	11-7PM	1.4
Saturday	18	1-9AM	0.9
Sunday	19	6-2AM	1.6
Monday	20	12-8AM	1.2
Tuesday	21	4-12PM	0.4
Wenesday	22	4-12PM	1.6
Thursday	23	11-7AM	2.0
Friday	24	11-7PM	1.6
Saturday	25	4-12PM	1.1
Sunday	26	8-5AM	0.6
Monday	27	4-12PM	1.9
Tuesday	28	1-9PM	1.2
Wednesday	29	1-10PM	0.9

* Recorded values are well below .0 (.02) for the entire day-

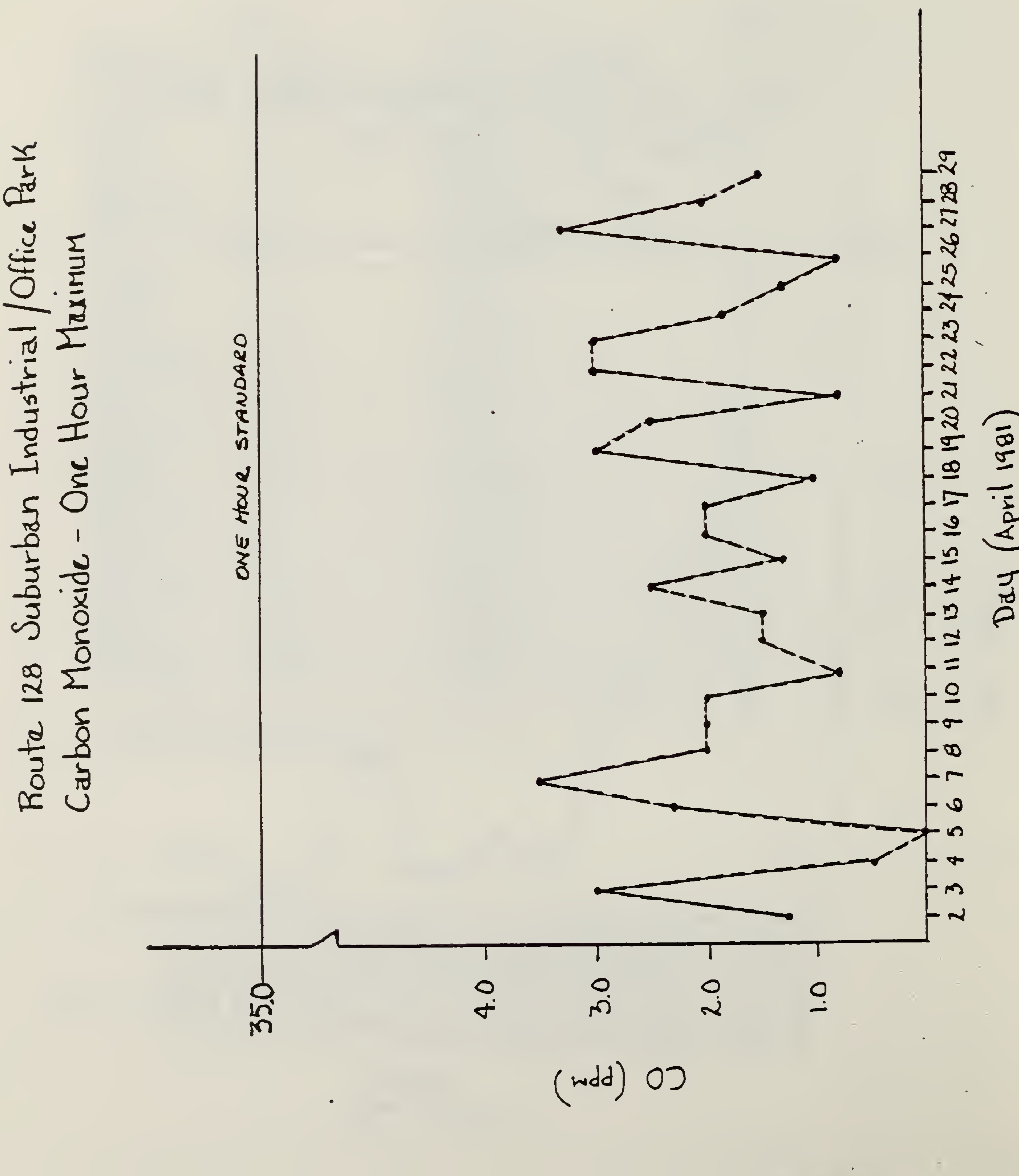
SOURCE: DEQE

Figure 1
Route 128 Suburban Industrial/Office Park
Carbon Monoxide - Peak Day
April 7, 1981



SOURCE: DEQE

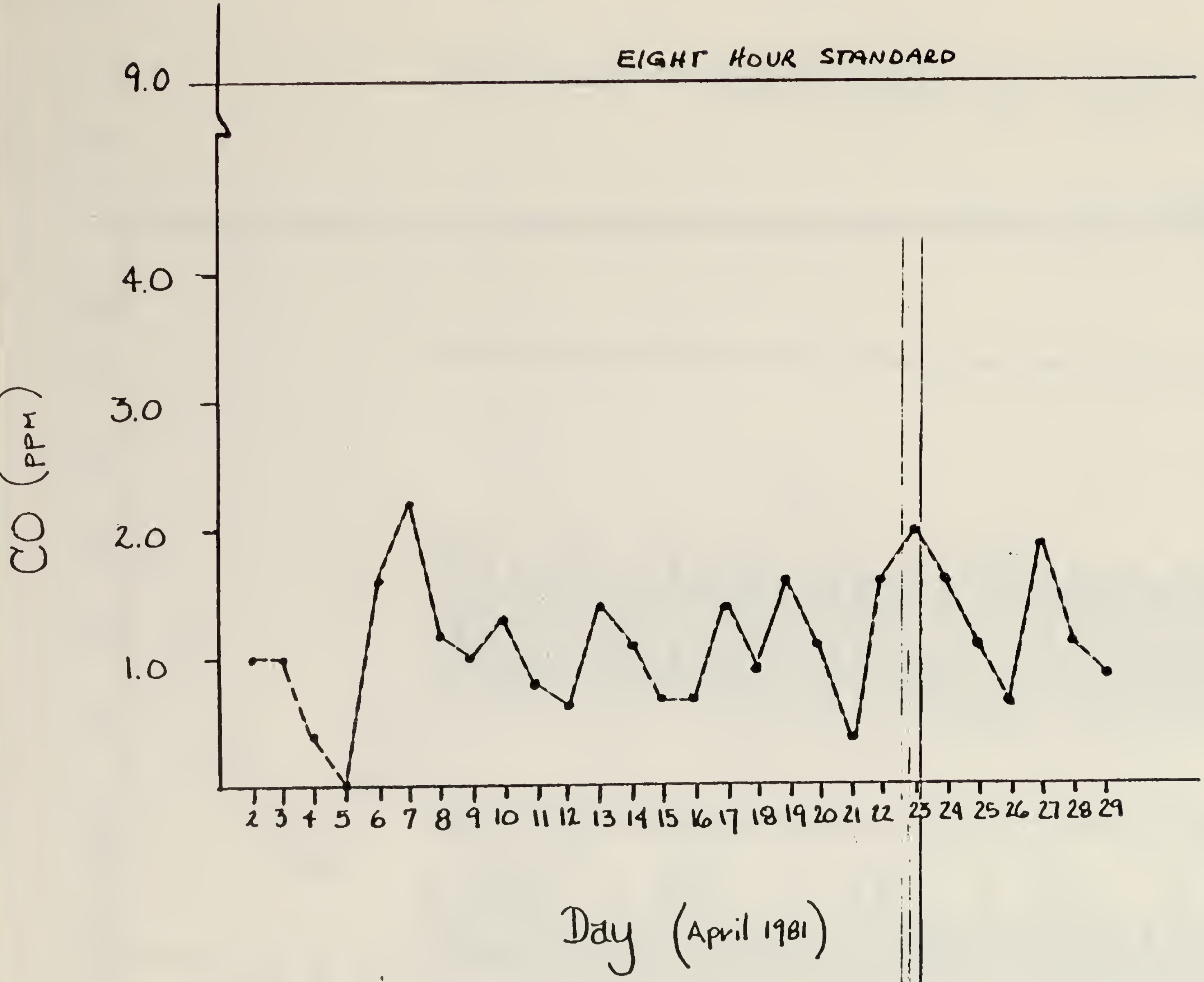
FIGURE 2



SOURCE: DEQE

FIGURE 3

Route 128 Suburban Industrial / Office Park
Carbon Monoxide - Eight Hour Maximum



SOURCE: DEQE

TABLE 3

1982 MONITORING SEASON RESULTS: CARBON MONOXIDE

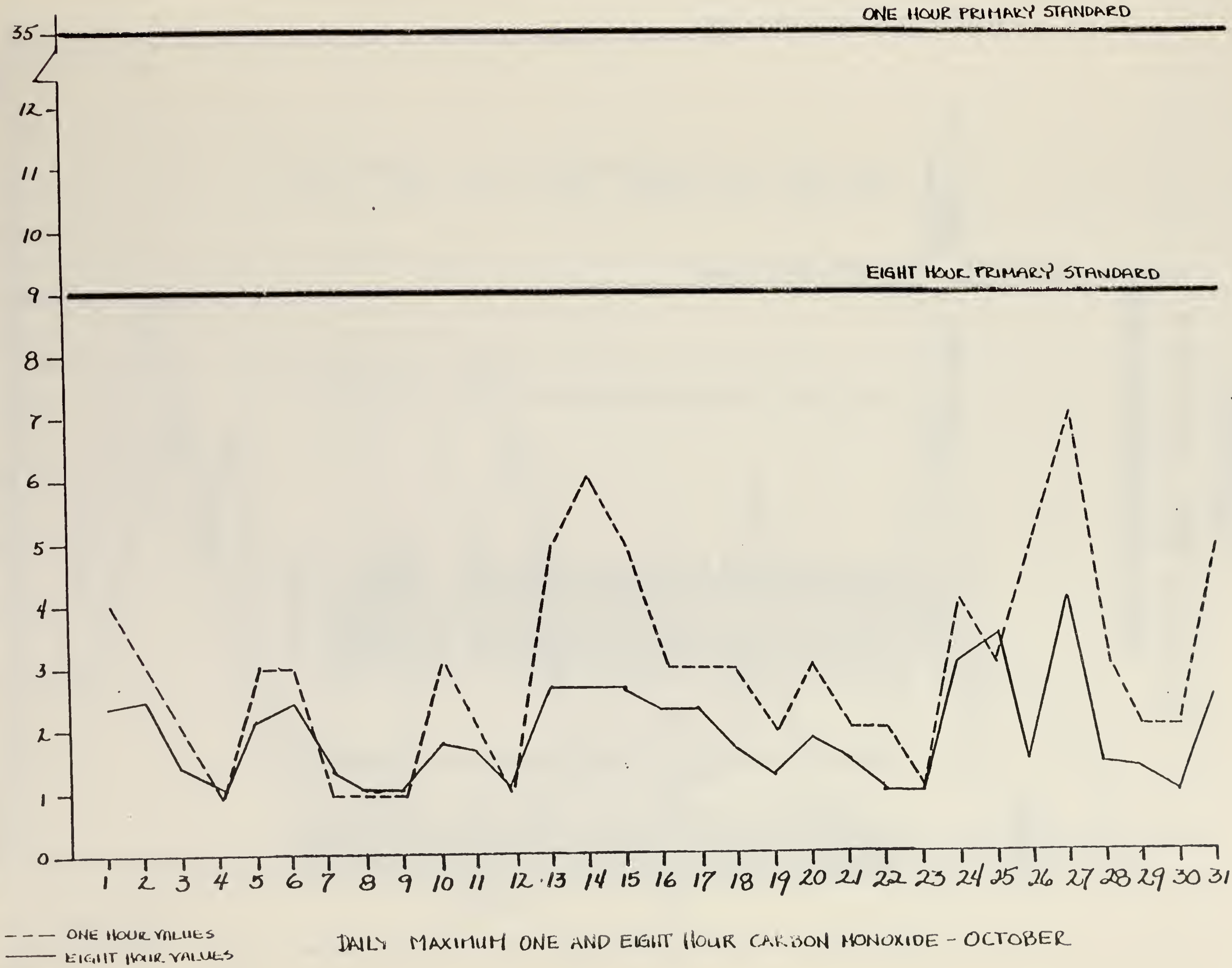
SUMMARY 1-HOUR MAXIMUM/8-HOUR MAXIMUM

October

Day		Time of Day (Hour)	One Hr. Max.	Eight Hr. Max.
Thursday	1	4-5pm/1-11pm	4	2.3
Friday	2	8-9am/7-2pm	3	2.4
Saturday	3	7-8pm/4-11pm	2	1.3
Sunday	4	6-7pm/6-1am	1	1
Monday	5	6-7pm/4-11pm	3	2.1
Tuesday	6	4-5pm/10-5pm	5	2.3
Wednesday	7	4-5pm/4-11pm	2	1.3
Thursday	8	4-5pm/4-11pm	1	1
Friday	9	4-5pm/4-11pm	1	1
Saturday	10	10-11pm/7-2am	3	2.0
Sunday	11	10-11pm/7-2am	2	1.6
Monday	12	7-8am/7-2pm	1	1
Tuesday	13	7-8am/3-10am	5	2.6
Wednesday	14	6-7am/2-9am	6	2.6
Thursday	15	8-9am/2-9am	5	2.6
Friday	16	4-5am/2-9am	3	2.3
Saturday	17	9-10am/7-2am	3	2.3
Sunday	18	1-2am/9-4am	3	1.6
Monday	19	4-5pm/4-11pm	2	1.4
Tuesday	20	4-5pm/3-10pm	3	1.8
Wednesday	21	3-4pm/3-10pm	2	1.4
Thursday	22	4-5pm/4-11pm	2	1
Friday	23	4-5pm/4-11pm	1	1
Saturday	24	8-9pm/6-1am	4	3
Sunday	25	1-2am/7-2am	3	3.4
Monday	26	11-12pm/11-6pm	5	1.5
Tuesday	27	5-6pm/2-9pm	7	4
Wednesday	28	8-9am/6-1pm	3	1.4
Thursday	29	8-9pm/4-11pm	2	1.3
Friday	30	9-10am/6-1am	2	1
Saturday	31	11-12pm/5-12pm	5	2.4

SOURCE: DEQE

FIGURE 4



DAILY MAXIMUM ONE AND EIGHT HOUR CARBON MONOXIDE - OCTOBER

TABLE 4

1982 MONITORING RESULTS: CARBON MONOXIDE

SUMMARY 1-HOUR MAXIMUM/8-HOUR MAXIMUM

November

Day		Time of Day (Hour)	One Hr. Max.	Eight Hr. Max.
Sunday	1	4-5pm/1-8am	3	3
Monday	2	5-6pm/12-7pm	5	2.9
Tuesday	3	8-9pm/5-12pm	7	4.8
Wednesday	4	9-10pm/6-1am	9	7
Thursday	5	5-6pm/4-11pm	5	6.4
Friday	6	5-6pm/4-11pm	7	3.3
Saturday	7	5-6pm/4-11pm	1	1
Sunday	8	7-8pm/4-11pm	2	1.3
Monday	9	8-9pm/5-12pm	4	1.5
Tuesday	10	4-5pm/3-10pm	4	1
Wednesday	11	7-8pm/4-11pm	5	2.4
Thursday	12	7-8pm/4-11pm	7	3.9
Friday	13	8-9pm/7-2am	8	6.1
Saturday	14	1-2am/7-2am	5	6.6
Sunday	15	2-3am/1-8am	1	1
Monday	16	6-7pm/5-12pm	2	1.3
Tuesday	17	8-9pm/4-11pm	3	1.4
Wednesday	18	3-4pm/3-10pm	2	1.3
Thursday	19	1-2am/1-8am	1	1
Friday	20	5-6pm/5-12pm	6	3.4
Saturday	21	4-5pm/4-11pm	2	1.4
Sunday	22	-	-	-
Monday	23	1-2am/ -	1	-
Tuesday	24	6-7pm/4-11pm	3	2.3
Wednesday	25	8-9pm/5-12pm	11	6.8
Thursday	26	5-6pm/4-11pm	2	1
Friday	27	8-9pm/5-12pm	3	1
Saturday	28	11-12pm/ -	2	-
Sunday	29	-	-	-
Monday	30	6-7pm/5-12pm	4	2.3

SOURCE: DEQE

FIGURE 5

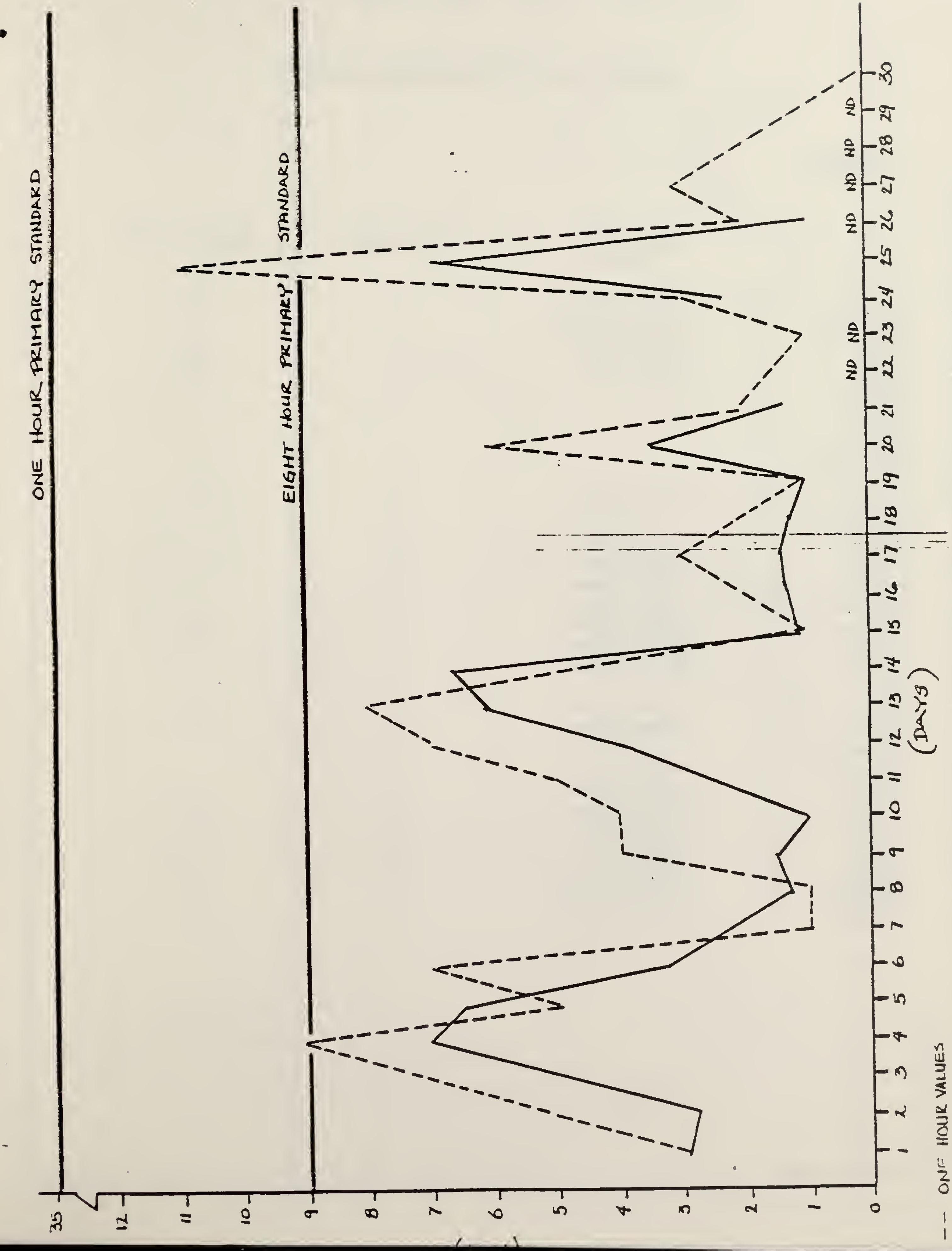

ONE HOUR PRIMARY STANDARD
EIGHT HOUR PRIMARY STANDARD
35
12
11
10
9
8
7
6
5
4
3
2
1
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
ND ND ND ND ND ND ND
(DAYS)
DAILY MAXIMUM ONE AND EIGHT HOUR CARBON MONOXIDE - NOVEMBER
-- ONE HOUR VALUES
— EIGHT HOUR VALUES

TABLE 5

1982 MONITORING RESULTS: CARBON MONOXIDE

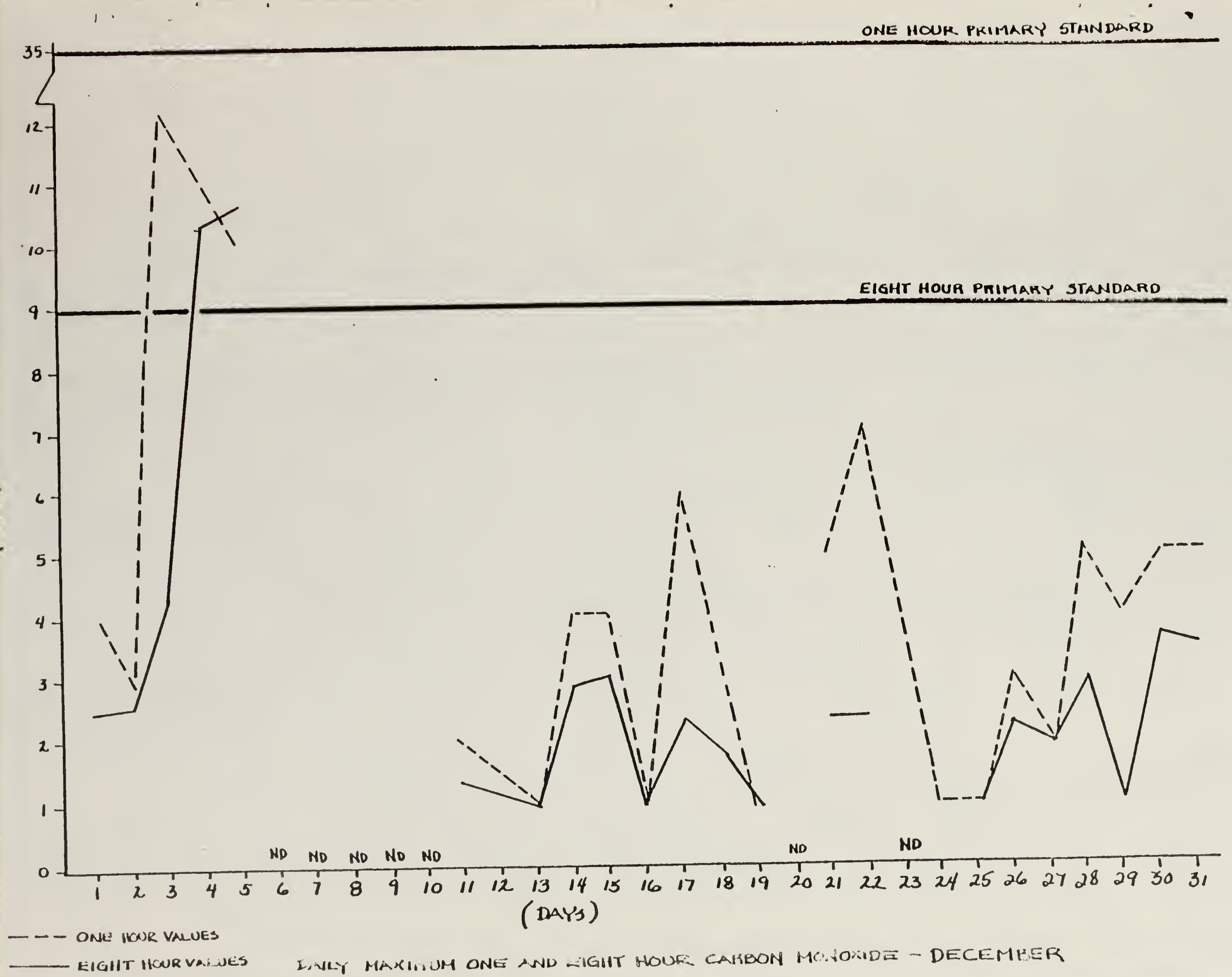
SUMMARY 1-HOUR MAXIMUM/8-HOUR MAXIMUM

December

Day		Time of Day (Hour)	One Hr. Max.	Eight Hr. Max.
Tuesday	1	6-7pm/4-11pm	4	2.5
Wednesday	2	10-11pm/10-5pm	3	2.6
Thursday	3	6-7pm/1-8pm	12	4.3
Friday	4	6-7pm/6-1am	11	10.3
Saturday	5	1-2am/6-1am	10	10.6
Sunday	6	-	-	-
Monday	7	-	-	-
Tuesday	8	-	-	-
Wednesday	9	-	-	-
Thursday	10	-	-	-
Friday	11	5-6pm/3-10pm	2	1.3
Saturday	12	-	-	-
Sunday	13	8-9pm/8-3am	1	1
Monday	14	8-9am/1-1pm	4	2.3
Tuesday	15	4-5pm/1-8pm	4	3
Wednesday	16	9-10pm/9-4pm	1	1
Thursday	17	5-6pm/11-6pm	6	2.3
Friday	18	5-6pm/11-6pm	3	1.9
Saturday	19	5-6pm/4-11pm	1	1
Sunday	20	-	-	-
Monday	21	5-6pm/10-5pm	5	2.4
Tuesday	22	5-6pm/10-5pm	7	2.4
Wednesday	23	-	-	-
Thursday	24	3-4pm/3-10pm	1	1
Friday	25	1-2am/8-3am	1	1
Saturday	26	5-6pm/5-12pm	3	2.3
Sunday	27	1-2am/6-1am	2	2.1
Monday	28	5-6pm/1-8pm	5	2.9
Tuesday	29	8-9am/4-11am	4	1
Wednesday	30	10-11pm/5-12pm	5	3.6
Thursday	31	6-7pm/4-11pm	5	3.5

SOURCE: DEQE

FIGURE 6



DAILY MAXIMUM ONE AND EIGHT HOUR CARBON MONOXIDE - DECEMBER

TABLE 6

1982 MONITORING RESULTS: CARBON MONOXIDE

SUMMARY 1-HOUR MAXIMUM/8-HOUR MAXIMUM

January

DAY		TIME OF DAY (hour)	ONE HR. MAX.	EIGHT-HR. MAX.
Friday	1	-	-	-
Saturday	2	-	-	-
Sunday	3	4-5 pm/4-11 pm	1	1
Monday	4	9-10 pm	1	-
Tuesday	5	-	-	-
Wednesday	6	5-6 pm/1-8 pm	3	1.1
Thursday	7	8-9 am/6-1 pm	4	1.8
Friday	8	5-6 pm/4-11 pm	2	1
Saturday	9	-	-	-
Sunday	10	-	-	-
Monday	11	5-6 pm/4-11 pm	3	1
Tuesday	12	8-9 am/6-1 pm	1	1
Wednesday	13	4-5 pm/4-11 pm	2	1
Thursday	14	-	-	-
Friday	15	6-7 pm/4-11 pm	3	1
Saturday	16	-	-	-
Sunday	17	6-7 pm/4-11 pm	1	1
Monday	18	5-6 pm/5-12 pm	6	2.9
Tuesday	19	6-7 pm/6-1 am	16	8.4
Wednesday	20	5-6 pm/12-7 pm	4	1.9
Thursday	21	5-6 pm/4-11 pm	2	1
Friday	22	5-6 pm/4-11 pm	3	1.4
Saturday	23	10-11 am/8-2 pm	2	1
Sunday	24	-	0	0
Monday	25	9-10 pm/7-1 pm	2	1
Tuesday	26	5-6 pm/4-11 pm	2	1
Wednesday	27	5-6 pm/4-11 pm	9	6.4
Thursday	28	1-2 am/6 pm-1 am	3	8
Friday	29	5-6 pm/4-11 pm	4	1.9
Saturday	30	7-8 am/4-11 am	2	1
Sunday	31	9-10 am/8-3 pm	1	1

SOURCE: DEQE

FIGURE 7

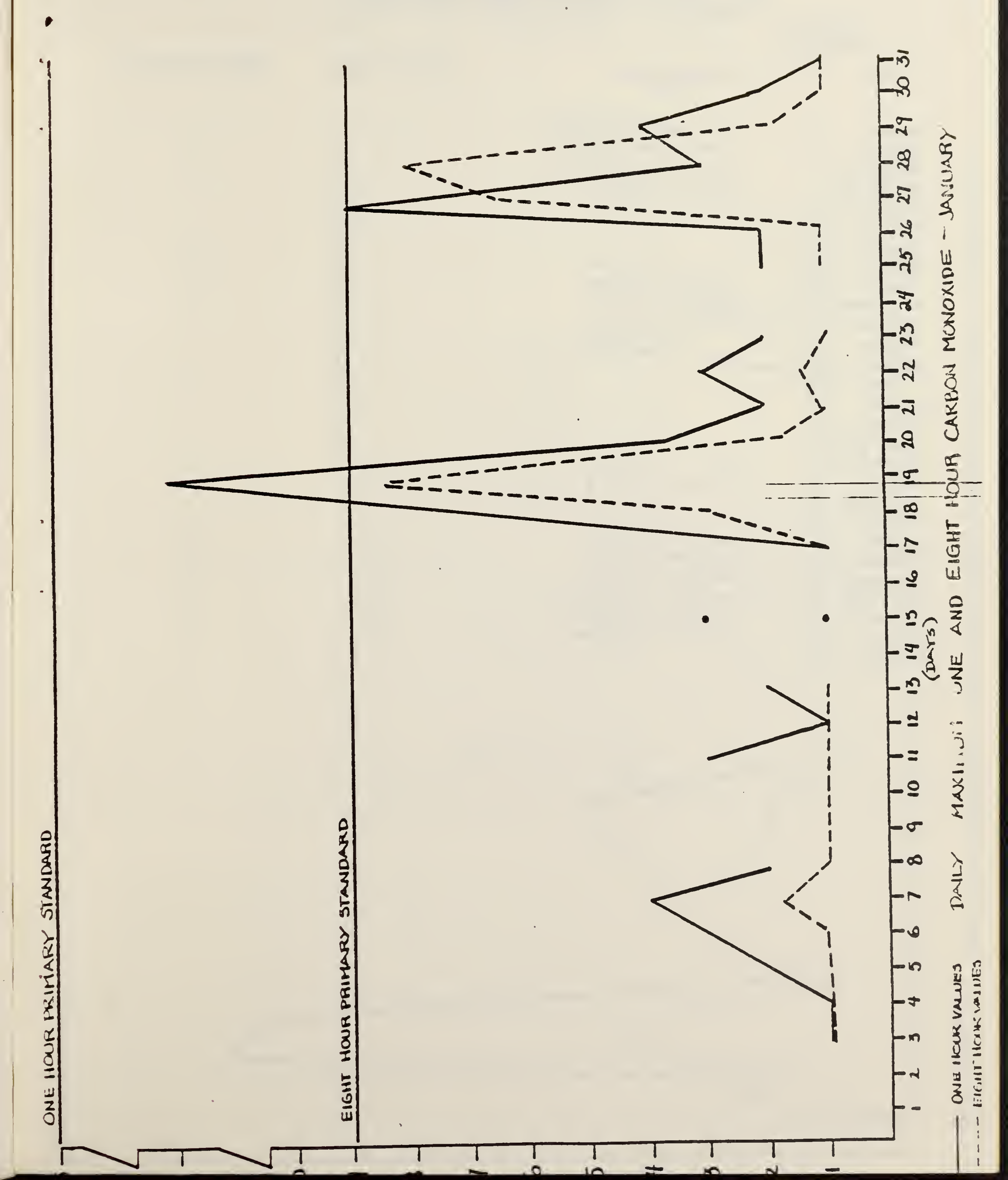

ONE HOUR PRIMARY STANDARD
EIGHT HOUR PRIMARY STANDARD
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
(DAYS)
DAILY MAXIMUM ONE AND EIGHT HOUR CARBON MONOXIDE - JANUARY
ONE HOUR VALUES
EIGHT HOUR VALUES

TABLE 7

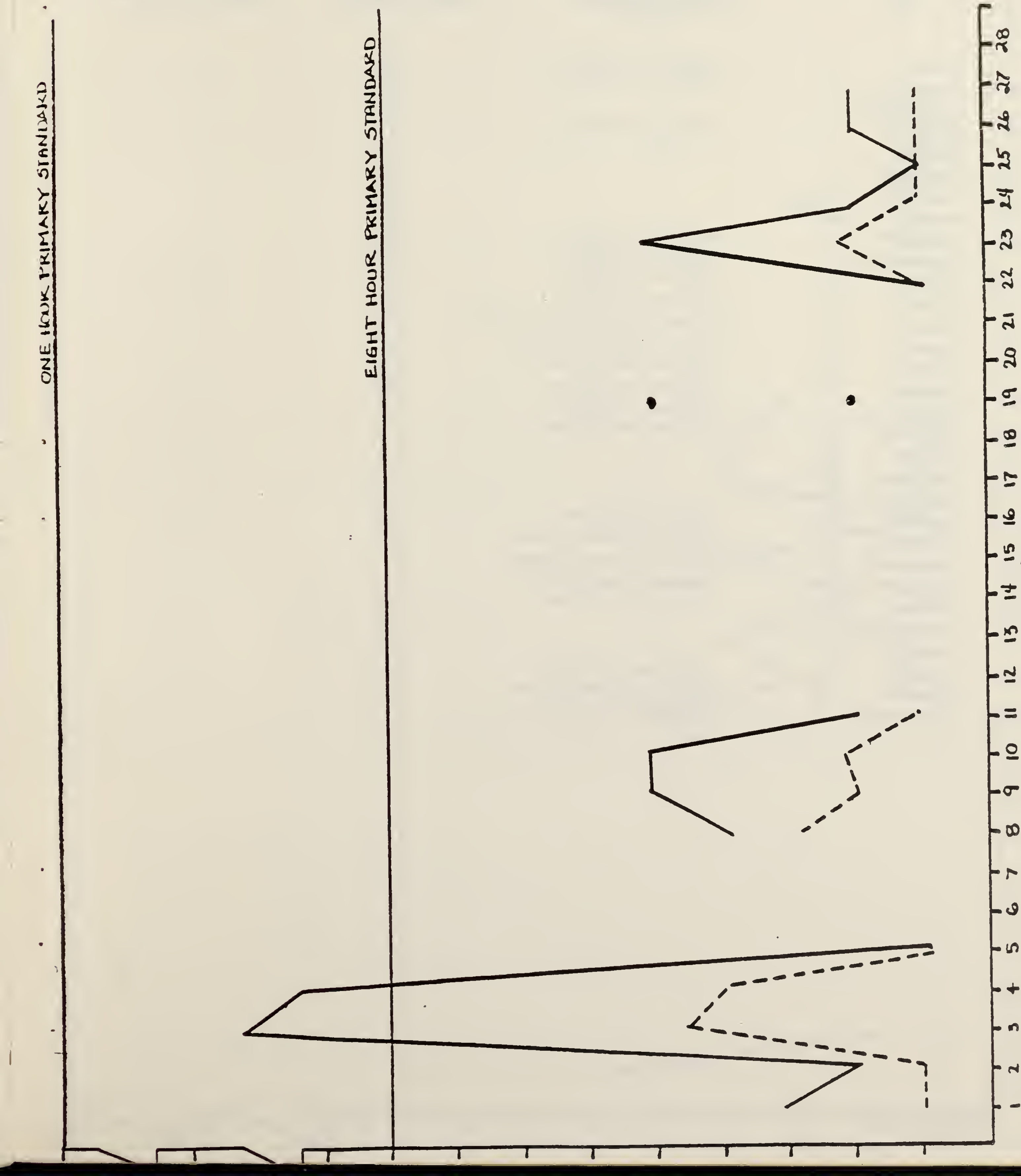
1982 MONITORING RESULTS: CARBON MONOXIDE
SUMMARY 1 - HOUR MAXIMUM/8 - HOUR MAXIMUM

February

Day		Time Of Day (Hour)	One Hour Max.	Eight Hour Max.
Monday	1	9-10a.m./6a.m.-1p.m.	3	1
Tuesday	2	8-9a.m./8am.-3p.m.	2	1
Wednesday	3	5-6p.m./12a.m.-7p.m.	12	4.5
Thursday	4	8-9p.m./3-10p.m.	11	4
Friday	5	8-9a.m./8-3p.m.	1	1
Saturday	6	-	-	-
Sunday	7	-	-	-
Monday	8	6-7p.m./5-12p.m.	4	2.8
Tuesday	9	4-5p.m./4-11p.m.	5	2
Wednesday	10	6-7p.m./4-11p.m.	5	2.1
Thursday	11	7-8p.m./7-2p.m.	2	1
Friday	12	-	-	-
Saturday	13	-	-	-
Sunday	14	-	-	-
Monday	15	-	-	-
Tuesday	16	-	-	-
Wednesday	17	-	-	-
Thursday	18	-	-	-
Friday	19	8-9p.m./4-11p.m.	5	2
Saturday	20	-	-	-
Sunday	21	-	-	-
Monday	22	4-5p.m./3-10p.m.	1	1
Tuesday	23	5-6p.m./4-11p.m.	5	2.1
Wednesday	24	6-7p.m./4-11p.m.	2	1
Thursday	25	9-10p.m./4-11p.m.	1	1
Friday	26	6 7/p.m./4-11p.m.	2	1
Saturday	27	9-[illegible] /[illegible]-12p.m.	2	1
Sunday	28	-	-	-

SOURCE: DEQE

FIGURE 8



DAILY MAXIMUM ONE AND EIGHT HOUR CARBON MONOXIDE - FEBRUARY

— ONE HOUR VALUES

TABLE 8

1982 MONITORING SEASON RESULTS:CARBON MONOXIDE
SUMMARY 1 - HOUR MAXIMUM/8 - HOUR MAXIMUM

March

Day		Time Of The Day (Hour)	One Hour Max.	Eight Hour Max.
Monday	1	5-6p.m./4-11p.m.	6	1
Tuesday	2	9-10p.m./4-11p.m.	2	1
Wednesday	3	-	-	-
Thursday	4	5-6p.m./3-10p.m.	6	1
Friday	5	-	-	-
Saturday	6	-	-	-
Sunday	7	-	-	-
Monday	8	-	-	-
Tuesday	9	4-5p.m./3-10p.m.	4	1
Wednesday	10	5-6p.m./4-11p.m.	5	1
Thursday	11	5-6p.m./4-11p.m.	3	1
Friday	12	1-2p.m./8-3p.m.	4	2.1
Saturday	13	12p.m.-1a.m./12p.m.-7a.m.	2	1
Sunday	14	6-7a.m./12p.m.-7a.m.	4	1
Monday	15	4-5p.m./4-11p.m.	1	1
Tuesday	16	5-6p.m./4-11p.m.	4	1.2
Wednesday	17	6-7p.m./4-11p.m.	4	1
Thursday	18	5-6p.m./4-11p.m.	3	1
Friday	19	-	0	0
Saturday	20	-	0	0
Sunday	21	-	-	-
Monday	22	5-6p.m./2-9p.m.	1	1
Tuesday	23	11-12p.m./6p.m.-1a.m.	3	1.8
Wednesday	24	7-8p.m./7a.m.-2p.m.	1	1
Thursday	25	8-9a.m./7a.m.-2p.m.	1	1
Friday	26	4-5p.m./4-11p.m.	2	1
Saturday	27	-	-	-
Sunday	28	-	-	-
Monday	29	9-10p.m./4-11p.m.	3	1
Tuesday	30	7-8p.m./7a.m.-2p.m.	1	-
Wednesday	31	5-6p.m./4-11p.m.	2	1

SOURCE: DEQE

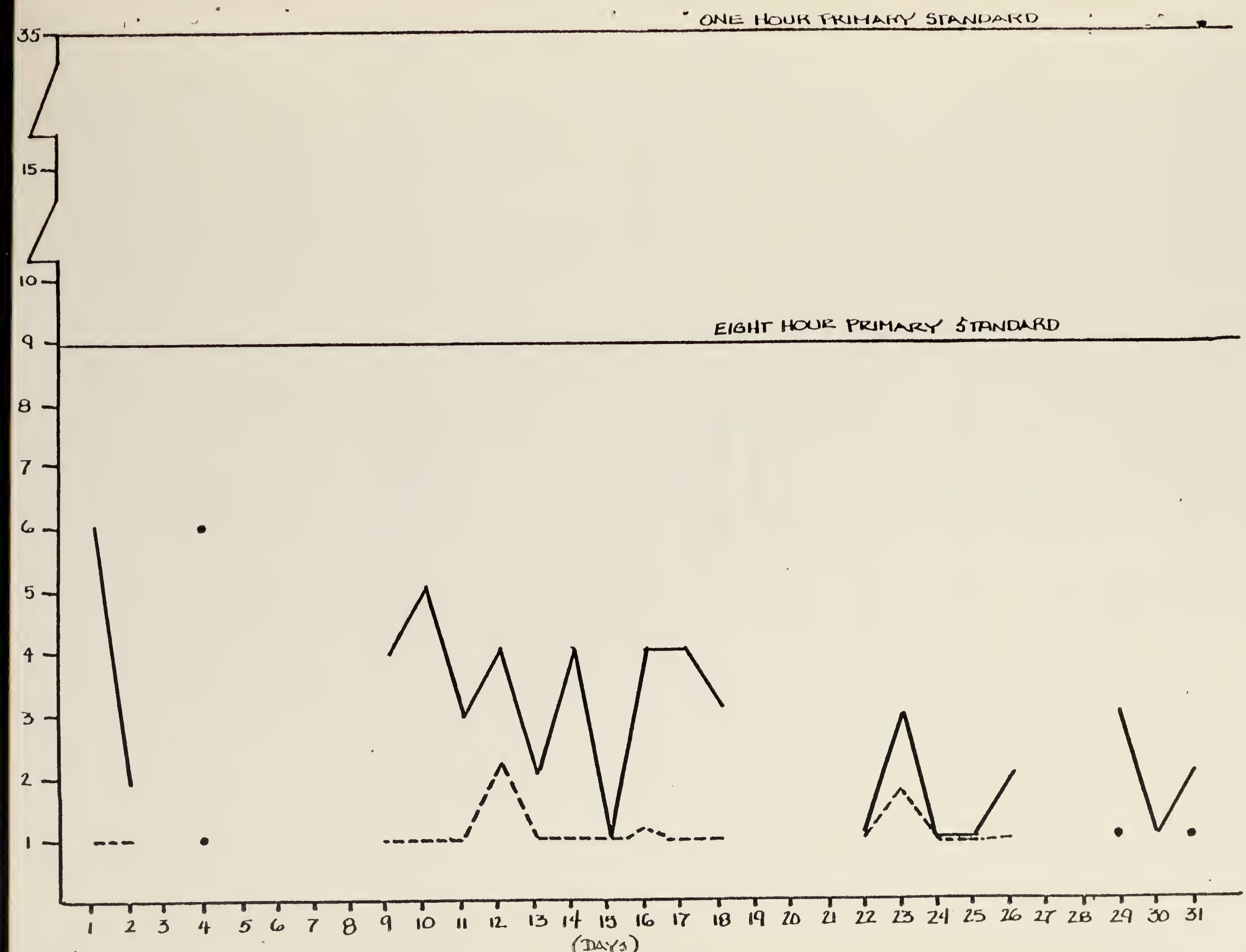


FIGURE 9

— ONE HOUR VALUES

-- EIGHT H...

... MAXIMUM ONE AND EIGHT HOUR CARBON MONOXIDE - MARCH

MOBILE 2B

EMISSION FACTOR

RUNS

STANDARD MOBILE-2 RUN DECK, 9./82. INFO: D.ERNST *NOTE NEW 81 REG FRAC*

*NON-METH HC EMISSION FACTORS INCLUDE EVAP. HC EMISSION FACTORS

CAL. YEAR: 1981 REGION: 49-STATE LOWALT. ALT: 500. FT.
TAMB: 75.0(F) 80.0/ 5.0/ 80.0

LDGV, LDGT1 AND LDGT2 I/M PROGRAM STARTING IN 1983
STRINGENCY LEVEL 20% MECH.TRAINING: YES
I/M PROGRAM BENEFITS APPLY ONLY TO MODEL YEARS 1971 THROUGH 1999

ATTENTION: THE DEFAULT VALUE OF 50% FOR TECHNOLOGY 4
I/M IDENTIFICATION RATE HAS BEEN LEFT UNCHANGED.

VEH. TYPE:	LDGV	LDGT1	LDGT2	LDGT	HDGV	LDDV	LDDT	HDDV	MC	ALL VEH
VEH. SPD.:	25.0	25.0	25.0		25.0	25.0	25.0	25.0	25.0	
VMT MIX:	.871	.042	.042		.017	.013	.002	.013	.000	
COMPOSITE EMISSION FACTORS (GM/MILE)										
NO-MTH HC:	5.31	4.86	5.22	5.05	11.52	.70	1.07	3.53	.00	5.30
EXHST CO:	63.29	58.20	54.37	56.28	179.36	1.69	2.33	10.40	.00	63.07
EXHST NOX:	3.36	3.58	3.87	3.73	10.45	1.63	2.01	23.62	.00	3.75
HOT STABILIZED IDLE EMISSION FACTORS (GM/MIN)										
NM-ID HC:	.75	.56	.50	.53	.92	.04	.11	.35	.00	.72
IDLE CO:	13.42	9.58	6.86	8.22	9.53	.18	.34	.89	.00	12.55
IDLE NOX:	.19	.08	.07	.07	.06	.20	.33	.92	.00	.19

OSURCE:DEQE

```
CAL. YEAR: 1981        REGION: 49-STATE LOWALT.           ALT: 500. FT.
                         TAMB: 75.0(F)       99.9/   .0/ 99.9
LDGV, LDGT1 AND LDGT2 I/M PROGRAM STARTING IN 1983
STRINGENCY LEVEL 20% MECH.TRAINING: YES
I/M PROGRAM BENEFITS APPLY ONLY TO MODEL YEARS 1971 THROUGH 1999
ATTENTION: THE DEFAULT VALUE OF 50% FOR TECHNOLOGY 4
  I/M IDENTIFICATION RATE HAS BEEN LEFT UNCHANGED.

VEH. TYPE:  LDGV   LDGT1   LDGT2   LDGT   HDGV   LDDV   LDDT   HDDV    MC   ALL VEH
VEH. SPD.: 20.0    20.0    20.0           20.0   20.0   20.0   20.0   20.0
  VMT MIX:   .871    .042    .042           .017   .013   .002   .013   .000

COMPOSITE EMISSION FACTORS (GM/MILE)
NO-MTH HC:   7.11    6.61    7.16   6.89  14.32    .94   1.42   4.21    .00    7.08
EXHST  CO:  92.40   85.26   80.61  72.93 228.58   2.45   3.39  13.16    .00   91.55
EXHST NOX:   3.17    3.35    3.72   3.53  10.01   1.84   2.27  25.60    .00    3.59

HOT STABILIZED IDLE EMISSION FACTORS (GM/MIN)
NM-ID  HC:    .75     .56            .53    .92    .04    .11    .35    .00     .72
 IDLE  CO:  13.42    9.56    [illegible]  8.22   9.53    .18    .34    .89    .00   12.55
 IDLE NOX:    .19     .08    [illegible]   .07    .06    .20    .33    .92    .00     .19
```

SOURCE: DEQE

STANDARD MOBILE-2 RUN DECK, 9./82. INFO: D.ERNST *NOTE NEW 81 REG FRAC*

*NON-METH HC EMISSION FACTORS INCLUDE EVAP. HC EMISSION FACTORS

CAL. YEAR: 1982 REGION: 49-STATE LOWALT. ALT: 500. FT.
TAMB: 75.0(F) 80.0/ 5.0/ 80.0

LDGV, LDGT1 AND LDGT2 I/M PROGRAM STARTING IN 1983
STRINGENCY LEVEL 20% MECH.TRAINING: YES
I/M PROGRAM BENEFITS APPLY ONLY TO MODEL YEARS 1971 THROUGH 1999
ATTENTION: THE DEFAULT VALUE OF 50% FOR TECHNOLOGY 4
I/M IDENTIFICATION RATE HAS BEEN LEFT UNCHANGED.

VEH. TYPE:	LDGV	LDGT1	LDGT2	LDGT	HDGV	LDDV	LDDT	HDDV	MC	ALL VEH
VEH. SPD.:	30.0	30.0	30.0		30.0	30.0	30.0	30.0	30.0	
VMT MIX:	.871	.042	.042		.017	.013	.002	.013	.000	
COMPOSITE EMISSION FACTORS (GM/MILE)										
NO-MTH HC:	4.09	3.75	3.62	3.69	9.14	.54	.95	3.03	.00	4.08
EXHST CO:	47.78	44.29	38.52	41.41	144.92	1.36	1.98	8.60	.00	47.69
EXHST NOX:	3.35	3.71	3.76	3.74	10.90	1.46	1.96	22.59	.00	3.74
HOT STABILIZED IDLE EMISSION FACTORS (GM/MIN)										
NM-ID HC:	.70	.49	.39	.44	.84	.03	.12	.35	.00	.66
IDLE CO:	12.45	8.33	5.50	6.92	9.19	.18	.35	.89	.00	11.59
IDLE NOX:	.19	.07	.06	.07	.06	.19	.35	.92	.00	.19

SOURCE: DEQE

```
CAL. YEAR: 1982        REGION: 49-STATE LOWALT.              ALT:  500. FT.
                         TAMB: 75.0(F)         99.9/   .0/ 99.9
LDGV, LDGT1 AND LDGT2 I/M PROGRAM STARTING IN 1983
STRINGENCY LEVEL 20% MECH.TRAINING: YES
I/M PROGRAM BENEFITS APPLY ONLY TO MODEL YEARS 1971 THROUGH 1999
ATTENTION: THE DEFAULT VALUE OF 50% FOR TECHNOLOGY 4
  I/M IDENTIFICATION RATE HAS BEEN LEFT UNCHANGED.

VEH. TYPE:  LDGV   LDGT1   LDGT2   LDGT    HDGV    LDDV    LDDT    HDDV    MC    ALL VEH
VEH. SPD.: 24.0    24.0    24.0            24.0    24.0    24.0    24.0   24.0
  VMT MIX:   .871   .042    .042            .017    .013    .002    .013   .000

COMPOSITE EMISSION FACTORS (GM/MILE)
NO-MTH HC:  5.62    5.23    5.09    5.16   11.25     .73    1.28    3.65    .00    5.58
EXHST  CO: 72.47   67.84   59.25   63.54  182.68    1.97    2.87   10.86    .00   71.74
EXHST NOX:  3.16    3.47    3.59    3.53   10.37    1.61    2.17   23.94    .00    3.56

HOT STABILIZED IDLE EMISSION FACTORS (GM/MIN)
NM-ID  HC:   .70     .49     .39     .44     .84     .03     .12     .35    .00     .66
 IDLE  CO: 12.45    8.33    5.50    6.92    9.19     .18     .35     .89    .00   11.59
 IDLE NOX:   .19     .07     .06     .07     .06     .19     .35     .92    .00     .19
-----------------------------------------------------------------------------------------
```

SOURCE: DEQE